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DEPARTMENT OF COMMERCE
BUREAU OF FISHERIES

REPORT

OF THE

UNITED STATES COMMISSIONER OF FISHERIES

FOR THE FISCAL YEAR 1923

WITH

APPENDIXES

HENRY O'MALLEY
Commissioner

WASHINGTON
GOVERNMENT PRINTING OFFICE
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AQUATIC PLANTS IN POND CULTURE. Second edition. By John W. Titcomb. Appendix II, 24 pp., 32 figs. (Document No. 948. Issued November 3, 1923.)

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PROPAGATION AND DISTRIBUTION OF FOOD FISHES, FISCAL YEAR 1923. By Glen C. Leach. Appendix XIII, 108 pp., 3 figs. (Document No. 964. Issued September 3, 1924.

DEPARTMENT OF COMMERCE.

BUREAU OF FISHERIES.

HEADQUARTERS STAFF, 1922-23.

Commissioner,

HENRY O'MALLEY.

Deputy Commissioner.—H. F. MOORE.
Assistants in Charge of Divisions:
Office.—IRVING H. DUNLAP.
Fish Culture.—GLEN C. LEACH.
Inquiry Respecting Food Fishes.—WILLIS H. RICH.
Fishery Industries.—HARDEN F. TAYLOR.
Alaska Service.—WARD T. BOWER.
Architect and Engineer.—GEORGE A. SCHNEIDER.
Accountant.—CHARLES W. SCUDDER.
Superintendent Central Station and Aquaria.—L. G. HARRON.

Bureau of Fisheries Document No. 946.

ANNUAL REPORT

OF THE

COMMISSIONER OF FISHERIES

TO THE

SECRETARY OF COMMERCE

FOR THE

FISCAL YEAR ENDED JUNE 30, 1923

WASHINGTON
GOVERNMENT PRINTING OFFICE
1923

BUREAU OF FISHERIES.

HEADQUARTERS STAFF, 1922–23.

Commissioner,
HENRY O'MALLEY.

Deputy Commissioner.—H. F. MOORE.
Assistants in Charge of Divisions:
Office.—IRVING H. DUNLAP.
Fish Culture.—GLEN C. LEACH.
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Bureau of Fisheries Document No. 946.

REPORT OF THE COMMISSIONER OF FISHERIES, 1923.

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DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
Washington, September 15, 1923.

SIR: I have the honor to submit herewith a report of the operations of the Bureau of Fisheries during the fiscal year ended June 30, 1923.

FISHERY INDUSTRIES SERVICES.

REVIEW.

The depression that existed in the fishery industries in 1921 was to a considerable extent relieved in 1922, as noted in my last report, and decidedly better conditions prevailed in the fiscal year 1923. In the New England vessel fisheries, in the calendar year 1922, 11.9 per cent fewer trips were made than in 1921, but the catch increased 6 per cent. Because of lower prices during part of the year there was a net decrease of 4.5 per cent from 1921 in the value of the product. In the spring of 1923, from January to May, inclusive, the landings were steadily greater than for 1922, except that in March, 1922, abnormally large landings were recorded, which were greater than the March, 1923, landings. In the first five months of 1923 the average price of fish landed from fishing vessels in New England was 4.64 cents per pound, as compared with 3.42 cents for the same period in 1922. At Seattle, in 1922, there was little change from the preceding year in either landings or value. In California, in 1923, there was an increase of 32.3 per cent in quantity over 1921, the production being 168,969,733 pounds.

In the Pacific Coast States the pack of canned salmon in 1922 showed a net decrease of 26.9 per cent in the number of cases and 6.5 per cent in value as compared with the pack of 1921; but this decrease was more than made up in Alaska, where there was an increase of 72 per cent in the number of cases and 51.7 per cent in value as compared with the previous year. The total pack of canned fishery products in the United States and Alaska in 1922 was valued at $60,464,947, an increase of 29.6 per cent over 1921. The by-products of the fisheries in 1922 were valued at $11,390,693, an increase of 36.4 per cent over their value in 1921.

Gratifying increases over the 1921 pack of sardines are recorded for both Maine and California in 1922. In Maine the increase amounted to 31.5 per cent in number of cases and 45.2 per cent in value; in California the increase amounted to 75.4 per cent in number of cases and 51.7 per cent in value. In the total sardine pack of both Maine and California there was an increase of 41.8 per cent in number of cases and 44.4 per cent in value.

The activities of the bureau included a market survey of Boston, Mass., similar to those previously made in other cities. In the field of statistics canvasses have been completed of the fisheries of New York, New Jersey, Pennsylvania, and Delaware for 1921, the shad and alewife fisheries of the Potomac River for 1922 and 1923, and the canned fishery products and by-products of the United States for 1922. The regular collections of statistics of the landings of the vessel fisheries at the ports of Boston and Gloucester, Mass., Portland, Me., and Seattle, Wash., have been carried out and the data published as statistical bulletins. The statistical bulletins of cold-storage holdings of frozen fish have also been issued monthly.

Technological investigations have included a continuation of experiments in the preservation of fish nets, including the preparation of a report of results up to January 1, 1923; freezing fish in brine; canning sardines; an examination into the possibilities of producing insulin, the newly discovered palliative for diabetes, from the pancreas of sharks; and certain work on the reddening of salt codfish.

The bureau also prepared and managed the exhibit of fisheries and fishery industries at the Brazilian International Centennial Exposition, which opened September 7, 1922, at Rio de Janeiro.

Broadcasting fisheries market reports was also begun and continued once a week for the benefit of the wholesale and retail fish trade.

FISH MERCHANDISING.

That part of the fish industry which has to do with distribution and sales remains the most important problem presented to those engaged in this business. The limit upon the volume of fish business that can be done at present is set by distribution rather than by production. The bureau has continued, in so far as its resources permitted, its efforts to be of service in this field.

In the autumn of 1922 a survey was made of the fish trade of Boston, Mass., our largest fishing port.

Boston, with a population of 748,060, is the principal landing port for the fisheries of the North Atlantic. It is also the greatest fishing port in the United States and among the greatest of the world's fishing ports. In the calendar year 1922 there were landed at Boston by vessels of 5 tons or over 106,190,403 pounds of fish, valued at $4,020,105. More than 80 per cent of its fishing business, on the basis of quantity, is in cod, haddock, halibut, mackerel, swordfish, and lobsters, a very different group of fish from those prominent in Seattle. A moderate or limited business is also done in alewives, butterfish, carp, flounders, salmon, smelts, suckers, clams, crabs, and oysters, and some 54 other species. In Boston there were 108 wholesale fish dealers and 171 retailers—one retailer for each 6,926 persons.

The production or landings of fish in the year ended September 30, 1922, was 101,949,725 pounds, valued at $4,051,350. In the month of September, 1922, the following products were landed at Boston: Fish, 13,244,074 pounds; lobsters, 616,355 pounds; clams, 338,964 pounds; oysters, 10,068 gallons, or 80,544 pounds; scallops, 478 gallons, or 3,824 pounds. The amount of fish frozen during 1922 was

8,946,183 pounds, and the amount shipped from Boston during September, 1922, was 14,383,761 pounds.

In the month of September, 1922, 56 per cent of all Boston's fish was consumed in Massachusetts, and 89 per cent in Massachusetts, Rhode Island, Connecticut, New York, and Pennsylvania. It is thus evident that while Boston has done much in developing her near-by market the more distant markets are still awaiting development. There is evidence also that this is the case with other centers of fish production. The per capita consumption of Boston fish in Massachusetts during the month of September, 1922, was over 1½ pounds, which must be increased by the fish taken at other Massachusetts ports, perhaps, to more than 2 pounds, or 24 pounds per capita annually. The per capita consumption of fish in the United States, as a whole, is probably not more than 12 or 14 pounds. This development of local fish consumption resulted in the shipment to Boston from the Pacific coast of 169 carloads of halibut and salmon during the year ended September 30, 1922, although Boston itself is the largest fish-producing port in the United States.

TECHNOLOGICAL INVESTIGATIONS.

It was pointed out, in connection with the discussion of the market survey of Boston, that the limit to the fish business was set by problems of distribution. The limit to extensive and successful distribution is fixed not only by incomplete organization of the industry but also by the lack of adequate methods of preserving and handling fish, so that they can be transported to distant markets in first-class edible condition. Other technical difficulties, such as the rapid decomposition of the nets he uses, further reduce the fisherman's reward for his arduous labors. Technological inquiry only can solve these problems, and it is in a continuation of such inquiries that the bureau's technological staff has been engaged.

BRINE-FREEZING OF FISH.

In Economic Circular No. 53, issued in 1921, the status of brine-freezing was outlined as it was at that time. It was pointed out that in principle brine-freezing seemed to have received sufficient test and approval by various scientific investigators, and that the chief problem ahead was the engineering problem of constructing a plant that would freeze fish on a large scale with a minimum of labor and expense. There has been constructed in the fishery products laboratory a brine-freezing apparatus of new design intended to meet these requirements. It consists of a tunnel 40 feet long provided with a short compartment at each end. The fish are suspended from horizontal bars that are mechanically conveyed through this tunnel. The fish first pass through a fresh-water spray in the entrance compartment for the purpose of washing; then through a violent spray of brine at —5 or —6° F. for 32 feet, wherein they are frozen; emerging from the brine spray, they again pass under a fresh-water spray, which removes the brine and applies a glaze. The conveyor is arranged for variable speed so that fish of different sizes may be

treated for the time required to freeze. The conveyor is located so that it is not exposed to the corrosive action of the brine. Mechanical refrigeration is used to refrigerate coils or heat-absorbing units located in the bottom of the apparatus. The salt brine is circulated continuously, only a small volume being required. Trials so far made with this apparatus indicate that it freezes quite satisfactorily, though more extensive trials will yet be necessary. The fish are individually frozen, trim and straight.

PRESERVATION OF NETS.

The bureau's work on the preservation of fish nets has been carried to the point of yielding results of value. The several series of samples of twine that had been exposed at several localities in 1922 and tested monthly were completed, and the results were prepared for publication. In addition to numerous well-known preservative materials, there was tried for the first time copper oleate, in which the bureau hoped to discover a better preservative than any of those hitherto used. In so far as experiments of this kind go, the results fully justified expectations. Copper oleate, dissolved in gasoline or other suitable solvent and applied to cotton or linen lines, effected a superior preservation of tensile strength or resisted fouling to a remarkable degree without materially adding weight to the lines or diminishing their flexibility, as so many other preservatives do. The results were very much more satisfactory in salt water than in fresh water. In the latter the copper oleate seems to be somewhat more soluble than in salt water. In a new and larger series of experimental exposures of lines begun in the spring of 1923 several other commercial or proprietary preservatives were tested, and an effort also was made to reduce the solubility of copper oleate in water by the addition of linseed oil and paraffin and by other combinations. Success in this direction, if attained, will not only provide a suitable preservative for fresh water but will overcome one of the principal objections to the use of copper oleate in salt water; that is, its tendency to wash out of the lines.

CANNING SARDINES.

In the canning of sardines it is always necessary to remove some of the water from the fish before the cans are finally sealed, else the fish break down to a wet mass and present a poor appearance. In California the usual method of removing the excess water is to pass the fish through a bath of hot oil, wherein much of the water is cooked out. At the bureau's experimental laboratory at San Pedro, Calif., the conclusion has been reached, and heretofore reported, that the oil in which the frying is done becomes oxidized, rancid, and objectionable from a dietetic point of view, since part of it is carried on the fish into the can. During the fiscal year 1923 work has been confined chiefly to the solution of the problem of removing the water by methods other than frying in oil, and considerable progress can be reported. Three methods were tried, all of which showed some merit. They were (*a*) cooking in strong brine instead

of oil, (*b*) steaming, and (*c*) canning raw after removal of excess water by brining and partial drying. A pack that appeared to be equal, if not superior, to any fried-in-oil product was made by a modified steaming process. Quite satisfactory products were prepared by the raw-pack method; that is, preliminary brining and drying, followed by sealing and processing. Good packs also were prepared by the method of cooking in brine, but this may perhaps be adjudged an unsatisfactory method because of the penetration of too much salt.

SALTING OF PACIFIC COAST MACKEREL.

Attention was given by the San Pedro laboratory to the salting of the Pacific Coast mackerel (*Scomber japonicus*). This fish is, in general, less fat than the Atlantic mackerel and its flesh is more likely to be dark in color. It was found, however, that the method that previously in the bureau's salting experiments had been found to be applicable to other fish in warm climates was here successful. This process consists in using high-purity salt applied dry to perfectly fresh fish that have been thoroughly cleaned of all blood and viscera. These points all seem to be essential. Packers, who have themselves hit upon most of these points, have found by experience that salt of inferior quality produces inferior fish and that any blood left in the fish darkens it. Freshness is also important, so much so that salting aboard the boats seems advisable.

PEARL ESSENCE.

Pearl essence, an incidental product of the fisheries, has continued to attract considerable attention, perhaps more because of its spectacular beauty and novel application than because of its industrial importance. Nevertheless, the business of manufacturing imitation pearls, which was at one time an exclusively European and Japanese industry, has migrated to America to a very large extent. New York City and its vicinity are now the center of a considerable imitation-pearl industry, based largely on the supply of pearl essence produced in the United States principally from herring and alewife scales.

A process of making a pearl essence has been elaborated in the fishery products laboratory which, in technique, is a radical departure from any methods known to have been used hitherto. By this method the lustrous material from the scales is removed in water, together with any dirt, blood, slime, etc., that may accompany the scales. The crude suspension is then treated chemically in such a way that the lustrous or nacreous particles are removed bodily from the crude liquor and transferred to ether and then to ethyl or amyl acetate, which are solvents of nitrocellulose, which, when dissolved in the suspension, makes a pearl lacquer. This applied to glass beads makes the "indestructible" pearl of commerce. "Essence" has been prepared by this process from the scales of numerous species of fish. The details of the process will be published in a separate document.

PARTICIPATION IN THE BRAZILIAN INTERNATIONAL CENTENNIAL EXPOSITION.

In accordance with that part of the act of Congress authorizing participation of the United States in the Brazilian exposition that provided for a fisheries exhibit, the bureau assembled collections of fishery products, apparatus, vessel models, transparencies, photographs, motion pictures, etc. Among the more important exhibits were those of the salmon industry, the New England banks fisheries, the oyster industry, the menhaden industry, canning and by-products of the fisheries, fishing gear, preservation of nets, and organization and functions of the Bureau of Fisheries. A brief description of the fishery industries of the United States was prepared and printed in English, Spanish, and Portuguese for distribution at the exposition.

CANNED FISHERY PRODUCTS AND BY-PRODUCTS.

The bureau made a canvass of the canned fishery products and fishery by-products industries of the United States and Alaska for the year 1922. The total value of the canned fishery products for the year was $60,464,947, and the value of the fishery by-products prepared, such as fish oil, fertilizer, fish meal, liquid glue, poultry grit, and lime from shells, was $11,390,693. The results of the canvass were published and distributed to the trade as Statistical Bulletin No. 570.

The pack of canned salmon, reduced to the equivalent of 48 pounds of fish to the case, amounted to 5,234,898 cases, valued at $38,420,717, of which 4,501,652 cases, valued at $29,787,193, were packed in Alaska, and 733,246 cases, valued at $8,633,524, in the Pacific Coast States. Other canned-salmon products, valued at $71,248, were also prepared.

The pack of sardines in Maine in 1922 amounted to 1,775,878 cases, valued at $5,750,109, compared with 1,350,631 cases, valued at $3,960,916, in 1921. The pack of sardines in California in 1922 was 728,979 cases, valued at $3,361,480, compared with 415,587 cases, valued at $2,346,446, in 1921.

The canning of shad is confined to Washington, Oregon, and California. The pack of shad in 1922 amounted to 2,257 cases, valued at $9,961, and of shad roe to 433 cases, valued at $8,517. The shad are packed in half-pound flat, half-pound oval, and 1-pound tall cans; the shad roe in half-pound flat and 1-pound oval cans; all with 48 cans to a case.

The pack of canned alewives and alewife roe in 1922 was prepared in Maryland, Virginia, and North Carolina. The pack of alewives amounted to 1,043 cases, valued at $1,994, and of alewife roe to 38,298 cases, valued at $137,514.

The pack of canned albacore in California in 1922 amounted to 272,563 cases, valued at $2,304,935; canned tuna to 345,363 cases, valued at $1,989,977; canned bonito to 10,591 cases, valued at $58,900; canned yellowtail to 4,403 cases, valued at $18,994; and other canned products to 31,548 cases, valued at $182,033. These products were packed in cans of various sizes and mostly with 48 cans to a case.

Shrimp were canned in North Carolina, Georgia, Florida, Alabama, Mississippi, and Louisiana. The pack in 1922 amounted to 586,691 cases, valued at $3,064,087. Louisiana ranked first with a pack of 179,164 cases, valued at $951,302, and Mississippi ranked second with a pack of 174,466 cases, valued at $882,389. The greater part of the pack, or 545,402 cases, valued at $2,843,516, was put up in No. 1 cans, four dozen to the case. The remainder was packed in No. 1½ and No. 2½ cans, two dozen to the case, and No. 10 cans, one-half dozen to the case.

Crabs were canned at two plants in Virginia, five in Alaska, and one each in Maine and Washington, the pack amounting to 9,111 cases, valued at $104,171.

The pack of razor clams in 1922 was confined to Washington, Oregon, and Alaska and amounted to 139,656 cases, valued at $879,956. It included whole and minced clams and clam juice. The pack of hard clams, confined to Florida and Washington, amounted to 53,349 cases, valued at $298,042, and included whole and minced clams, clam bouillon, chowder, and juice. Soft clams were canned in Maine, Massachusetts, and Rhode Island, and the pack amounted to 116,635 cases, valued at $538,367, including whole clams, clam bouillon, chowder, and broth.

In 1922 oysters were canned in Maryland, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, and Louisiana. The pack amounted to 522,549 cases, valued at $2,423,616, compared with 455,550 cases, valued at $2,179,271, the previous year.

In addition to the canned products already referred to, there were packed in Maine, Massachusetts, New York, New Jersey, Maryland, Virginia, North Carolina, and Washington, 224,304 cases of miscellaneous fishery products, valued at $840,329.

In 1922 there were 45 factories engaged in the manufacture of products from menhaden, as compared with 39 factories in 1921. The number of menhaden utilized was 1,212,450,669, or 747,470,402 pounds, valued at $2,457,690. The products included 93,576 tons of scrap and fish meal, valued at $3,221,758, and 7,102,677 gallons of oil, valued at $2,904,833, the total value of the products amounting to $6,126,591.

The total production of fish oils in 1922, including menhaden oil, in the United States and Alaska amounted to 10,535,473 gallons, valued at $4,230,760. The various oils produced were as follows: Menhaden oil, 7,102,677 gallons, valued at $2,904,833; whale oil, 1,863,015 gallons, valued at $731,000; sperm oil, 384,130 gallons, valued at $153,714; herring oil, 450,362 gallons, valued at $150,144; sardine oil, 428,859 gallons, valued at $145,668; tuna oil, 86,099 gallons, valued at $62,702; salmon oil, 25,989 gallons, valued at $9,435; cod and cod-liver oil, 71,539 gallons, valued at $33,666; and miscellaneous fish oils, 122,803 gallons, valued at $39,598.

The production of fish scrap and meal, including menhaden, and shrimp bran in 1922 amounted to 116,166 tons, valued at $4,336,677. The production of dried scrap and meal was 89,459 tons, valued at $3,755,787; of acidulated scrap 25,712 tons, valued at $555,973; of crude or green scrap 433 tons, valued at $9,519; and of shrimp bran, 562 tons, valued at $15,398. Of the quantity of dried scrap produced in the menhaden industry 7,172 tons, valued at $390,677, were reported sold as fish meal.

In 1922 there were 56 plants engaged in converting oyster shells into poultry grit and lime. The poultry grit produced from this source amounted to 236,021 tons, valued at $2,005,838, and the lime to 93,168 tons, valued at $431,213.

Other by-products of the fisheries included fish glue, shark hides, agar-agar, pearl or fish-scale essence, shark fins, whalebones (skeletons), whale tails, ambergris, herring skins, and alewife scales, to the value of $386,205.

FROZEN-FISH TRADE.

Statistics of the cold-storage holdings of frozen fish have been collected and published by the Bureau of Markets, Department of Agriculture, beginning with October, 1916. These reports give the holdings on the fifteenth day of each month. Through the courtesy of that bureau arrangements were made in December, 1921, for the Bureau of Fisheries to publish and disseminate this information, beginning with the returns for January 15, 1922, in the form of a monthly statistical bulletin. This bulletin gives the holdings by species and sections, total holdings for the current month and for the same month of the previous year, the five-year average, holdings for the previous month, and the quantity of each species frozen during the month.

In 1922 there were in operation 274 freezers that were devoted wholly or partly to the cold storage of fish. The holdings were very much smaller in 1922 than they had been on the corresponding dates in several previous years. The smallest holdings were in May and the largest in November.

The greater part of the freezing of fish, or 80 per cent, was in the New England, Middle Atlantic (including the Great Lakes in New York and Pennsylvania), and the Northwestern States, which include Montana, Wyoming, Idaho, Washington, and Oregon. The total quantity of fish frozen during the year was 75,453,674 pounds. Of this quantity, 24.67 per cent was frozen in New England, 27.12 per cent in the Middle Atlantic, and 27.94 per cent in the Northwestern section. Compared with the previous year, there was a decrease of 3,720,218 pounds in the total quantity frozen. The principal species and quantities frozen during the year 1922 were salmon, 12,143,194 pounds; ciscoes, 10,245,252 pounds; herring, 7,964,778 pounds; mackerel, 6,165,248 pounds; whiting, 6,058,126 pounds; and halibut, 5,122,396 pounds. Several other species were frozen in large quantities, and miscellaneous fishes not shown separately by species amounted to 10,956,348 pounds.

NEW ENGLAND VESSEL FISHERIES.

The bureau through its local agents has collected statistics of the vessel fisheries at Boston and Gloucester, Mass., and Portland, Me., which have been published in monthly and annual statistical bulletins. Two annual bulletins have been issued, one showing the catch by months and the other by fishing grounds. There was a decrease in the number of trips with an increase in the quantity and a decrease in the value of the products landed at these ports as compared with the previous year. At Portland, while there was a de-

crease in the number of trips, there was an increase in both the quantity and value of the products landed.

The fishing fleet at these ports during the calendar year 1922 numbered 338 sail, steam, and gasoline-screw vessels, including 28 steam trawlers. These vessels landed at Boston 2,893 trips, aggregating 106,190,403 pounds of fish, valued at $4,020,105; at Gloucester, 1,653 trips, aggregating 37,751,223 pounds, valued at $813,353; and at Portland, 1,803 trips, aggregating 15,933,765 pounds, valued at $632,474. The total for the three ports amounted to 6,349 trips, aggregating 159,875,391 pounds of fresh and salted fish, having a value to the fishermen of $5,465,932.

Compared with the previous year, there was a decrease of 857 trips, or 11.89 per cent, in the total number landed by the fishing fleet at Boston, Gloucester, and Portland, and an increase of 9,010,285 pounds, or 5.97 per cent, in the quantity, with a decrease of $256,697, or 4.48 per cent, in the value of the products landed. There was an increase in the quantity of all of the important species except pollock and halibut, and a decrease in the value of all except hake, herring, and swordfish. The catch of cod increased 1,665,151 pounds, or 3.11 per cent, in quantity and decreased $95,488, or 5.51 per cent, in value; haddock increased 2,783,289 pounds, or 4.12 per cent, in quantity and decreased $236,770, or 11.57 per cent, in value; cusk increased 149,035 pounds, or 7.10 per cent, in quantity and decreased $3,277, or 8.66 per cent, in value; and mackerel increased 1,342,567 pounds, or 39.67 per cent, in quantity and decreased $59,127, or 17.61 per cent, in value. Hake increased 838,139 pounds, or 18.47 per cent, in quantity and $1,728, or 15.76 per cent, in value; herring, 30,814 pounds, or 1 per cent, in quantity and $40,747, or 100.84 per cent, in value; and swordfish, 1,684,103 pounds, or 105.41 per cent, in quantity and $128,610, or 40.39 per cent, in value. Pollock decreased 1,847,926 pounds, or 26.60 per cent, in quantity and $46,636, or 28.32 per cent, in value; and halibut, 41,879 pounds, or 0.73 per cent, in quantity and $19,017, or 2.36 per cent, in value. The catch of Newfoundland herring increased from 551,400 pounds, valued at $19,584, in 1921, to 2,302,420 pounds, valued at $76,855, in 1922. In the various other species combined there was an increase of 2,406,992 pounds, or 77.73 per cent, in quantity and $32,533, or 23.90 per cent, in value.

The catch of scrod cod landed at these ports decreased from 1,150,577 pounds, valued at $10,844, in 1921, to 815,371 pounds, valued at $9,200, in 1922; and the catch of scrod haddock increased from 30,562 pounds, valued at $535, in 1921, to 253,283 pounds, valued at $4,261, in 1922. The small quantity of these grades landed, as compared with other grades of these species, is said to be due to the fact that the price is so low that the fishermen do not save all that are caught.

The fishery products landed at Boston, Gloucester, and Portland by fishing vessels each year are taken principally from fishing grounds off the coast of the United States. In the calendar year 1922, 78.96 per cent of the quantity and 75.27 per cent of the value of the catch landed by fishing vessels were from these grounds; 4.16 per cent of the quantity and 8.17 per cent of the value, consisting chiefly of cod, halibut, and herring, were from fishing banks off the coast of Newfoundland, and 16.88 per cent of the quantity and 16.56

per cent of the value from fishing grounds off the Canadian Provinces. There was some falling off in the percentage of products from grounds off the United States, with a small increase in that from grounds off Newfoundland and the Canadian Provinces compared with the previous year. Newfoundland herring constituted 1.44 per cent of the quantity and 1.40 per cent of the value of the fishery products landed at these ports during the year. The herring were taken from the treaty coast of Newfoundland and the cod, haddock, hake, halibut, and other species of that region were obtained from fishing banks on the high seas. All fish caught by American fishing vessels off the coast of the Canadian Provinces were from offshore fishing grounds.

Haddock ranked first in both quantity and value in the vessel fisheries at these ports in 1922, the catch amounting to 70,195,998 pounds, valued at $1,809,400, all landed fresh except 131,385 pounds salted, valued at $2,736. The catch of cod was 55,180,165 pounds, valued at $1,635,279, including 5,006,170 pounds salted, valued at $188,552. The catch of hake was 5,374,247 pounds, valued at $111,331, all landed fresh except 32,910 pounds salted, valued at $555. The greater part of the catch was landed at Boston. The catch of pollock was 5,097,085 pounds, valued at $118,006, all landed fresh except 49,300 pounds salted, valued at $938. The catch of cusk was 2,247,450 pounds, valued at $34,552, all landed fresh except 53,435 pounds salted, valued at $1,204. The catch of halibut was 5,624,149 pounds, valued at $784,057, all landed fresh except 15,706 pounds salted, valued at $915. There was a small decrease in the catch of halibut in both quantity and value as compared with the previous year. The quantity landed at Boston was 3,948,456 pounds, valued at $550,735; at Gloucester, 58,058 pounds, valued at $7,696; and at Portland, 1,617,635 pounds, valued at $225,626. The catch of swordfish was 3,281,748 pounds, valued at $447,016; and of flounders, 3,281,327 pounds, valued at $134,749. The catch of herring amounted to 2,644,354 pounds, valued at $81,154. Of this quantity, 341,934 pounds, valued at $4,299, were taken off the coast of the United States and landed fresh, and the remainder, including 410,000 pounds fresh, frozen, valued at $20,500, and 1,892,420 pounds salted, valued at $56,355, were Newfoundland herring.

The total catch of fresh mackerel taken by the American fishing fleet in 1922 was 53,703 barrels, compared with 40,323 barrels in 1921, an increase of 13,380 barrels. The total catch of salted mackerel was 2,749 barrels, compared with 3,242 barrels in 1921, a decrease of 493 barrels. The quantity of mackerel landed at Boston, Gloucester, and Portland by the fishing fleet in 1922 was 4,726,747 pounds, valued at $276,499, of which 4,266,367 pounds, valued at $239,111, were fresh and 460,380 pounds, valued at $37,388, were salted.

In 1923 the total catch of mackerel up to July 1 was 22,866 barrels fresh and 217 barrels salted, compared with 25,090 barrels fresh and 2,344 barrels salted for the same period in 1922. The southern mackerel fleet numbered about 25 purse-seine vessels and 136 gill-net vessels. Both seiners and netters had poor success on account of windy weather and scarcity of fish during the spring months. The first catch was landed at Norfolk April 9, consisting of 300 pounds of large mackerel, which sold at 75 cents per pound in New York. This

was three days earlier than the landing of the first catch the previous year. A considerable quantity of tinker mackerel scattered in small schools was reported in the south. The first catch of mackerel from Cape Shore was landed at Yarmouth, Nova Scotia, May 29, consisting of 4,000 pounds of large mackerel, which were shipped to Boston. The first arrival at Boston, direct from the fleet, was on June 7, consisting of 20,000 pounds of large mackerel, which sold at 6½ cents per pound. Fresh mackerel sold during the season from 6½ to 40 cents per pound, according to market conditions, and salted mackerel from Cape Shore sold at $11 per barrel.

VESSEL FISHERIES AT SEATTLE, WASH.

Statistics of the vessel fisheries at Seattle, Wash., have been collected by the local agent and published as monthly and annual statistical bulletins, giving the quantity and value of fishery products landed by American fishing and collecting vessels during the year at that port.

The fishing fleet at Seattle in 1922 landed 836 trips, amounting to 11,332,050 pounds of fish, having a value to the fishermen of $1,249,822, from fishing grounds along the coast from Oregon to Portlock Bank, Alaska. The largest quantities were taken from Flattery Banks, west coast of Vancouver Island, and Hecate Strait. The products included halibut, 9,938,150 pounds, valued at $1,196,390; sablefish, 1,014,100 pounds, valued at $46,652; "lingcod," 258,200 pounds, valued at $4,509; and rockfishes, 121,600 pounds, valued at $2,271. Compared with the previous year there was a decrease of 30 trips by fishing vessels and 2,334,650 pounds, or 17.08 per cent, in the quantity and $173,481, or 12.18 per cent, in the value of the products. There was a decrease in the catch of halibut of 1,542,850 pounds, or 13.43 per cent, in quantity and $139,268, or 10.42 per cent in value. The catch of sablefish decreased 505,300 pounds, or 33.25 per cent, in quantity and $17,033, or 26.74 per cent, in value. The catch of "lingcod" decreased 205,100 pounds, or 44.27 per cent, in quantity and $11,882, or 72.49 per cent, in value; and the catch of rockfishes decreased 81,400 pounds, or 40.09 per cent, in quantity and $5,298, or 69.99 per cent, in value.

The fishery products taken in Puget Sound and landed at Seattle by collecting vessels during the year amounted to 15,083,390 pounds, valued at $964,832. This quantity included 13,615,780 pounds of salmon, valued at $882,481, and the remainder consisted of herring, sturgeon, steelhead trout, smelt, perch, rockfishes, "lingcod," flounders, sole, and crabs. Compared with the previous year there was an increase in the products landed by collecting vessels of 2,654,865 pounds, or 21.36 per cent, in quantity and $185,954, or 23.87 per cent, in value.

FISHERIES OF CALIFORNIA.

Through the courtesy of the California Fish and Game Commission the bureau has received statistics of the catch of fish, by species and by counties, for California, and also the quantity of fish imported into California from Mexico during the calendar year 1922. The catch of fish taken in the waters of California in 1922 amounted to

168,969,733 pounds, compared with 127,728,623 pounds the previous year, an increase of 41,241,110 pounds, or 32.28 per cent. The species taken in largest quantities were pilchards, 93,399,900 pounds; albacore and tuna, 17,920,019 pounds; flounders, 11,341,262 pounds; bonito, or skipjack, 10,998,855 pounds; salmon, 7,235,124 pounds; barracuda, 4,710,753 pounds; rockfishes, 4,238,480 pounds; yellowtail, 3,111,198 pounds; mackerel, 2,466,762 pounds; white sea bass, or squeteague, 2,195,932 pounds; abalones, 1,523,394 pounds; and shad, 1,109,445 pounds.

The imports of fish from Mexico in 1922 amounted to 12,146,066 pounds, as compared with 6,699,817 pounds the previous year. The principal species imported were albacore and tuna, 6,179,754 pounds; barracuda, 1,528,770 pounds; bonito, or skipjack, 1,792,592 pounds; flounders, 817,304 pounds; white sea bass or squeteague, 736,220 pounds; sea crawfish or spiny lobster, 640,466 pounds; and yellowtail, 303,292 pounds.

FISHERIES OF NEW YORK, NEW JERSEY, PENNSYLVANIA, AND DELAWARE.

A canvass of the fisheries of New York, New Jersey, Pennsylvania, and Delaware was made for the calendar year 1921, and the results were published in condensed form as Statistical Bulletin No. 569.

The number of persons engaged in the fisheries of New York was 7,145, the investment was $13,836,455, and the products amounted to 210,377,152 pounds, valued at $4,986,918. The principal species taken, in the order of their value, were oysters, 9,500,295 pounds, or 1,357,185 bushels, valued at $1,785,913; menhaden, 179,447,799 pounds, valued at $1,117,235; flounders, 4,471,161 pounds, valued at $283,412; clams, 1,006,538 pounds, or 121,113 bushels, valued at $260,773; squeteagues, "sea trout," or weakfish, 1,921,036 pounds, valued at $228,524; scallops, 1,235,760, or 205,960 bushels, valued at $217,108; lobster, 1,037,395 pounds, valued at $196,762; and bluefish, 1,082,917 pounds, valued at $176,726. Compared with 1904, there was a decrease of 4,348, or 37.83 per cent, in the number of persons employed; an increase of $3,214,839, or 30.26 per cent, in the investment; and a decrease of 67,272,595 pounds, or 24.23 per cent, in the quantity and $1,243,640, or 19.96 per cent, in the value of the products.

The number of persons engaged in the fisheries of New Jersey was 5,771, the investment was $4,701,704, and the products amounted to 96,936,784 pounds, valued at $5,983,406. The principal species taken, in the order of their value, were oysters, 22,997,555 pounds, or 3,285,365 bushels, valued at $2,759,930; squeteagues, "sea trout," or weakfish, 11,651,735 pounds, valued at $902,439; bluefish, 2,243,425 pounds, valued at $390,947; clams, 925,588 pounds, or 112,111 bushels, valued at $385,198; scup or porgy, 4,115,552 pounds, valued at $200,046; butterfish, 2,862,491 pounds, valued at $159,286; flounders, 1,985,340 pounds, valued at $140,586; croaker, 3,815,554 pounds, valued at $126,700; menhaden, 30,405,093 pounds, valued at $121,451; and mackerel, 584,386 pounds, valued at $100,556. Compared with 1904, there was a decrease of 3,323, or 36.54 per cent, in the number of persons employed, but an increase of $2,015,908 in the investment, and of 6,828,716 pounds, or 7.57 per cent, in the quantity and $2,597,991, or 76.74 per cent, in the value of the products.

The number of persons engaged in the fisheries of Pennsylvania was 591, the investment was $1,375,778, and the products amounted to 594,613 pounds, valued at $44,621. The principal species taken, in the order of their value, were squeteagues, "sea trout," or weakfish, 240,000 pounds, valued at $14,400; sea bass, 135,000 pounds, valued at $12,500; scup or porgy, 142,000 pounds, valued at $7,100; shad, 18,872 pounds, valued at $5,834; suckers, 21,199 pounds, valued at $2,469; carp, 9,712 pounds, valued at $1,511; and alewives, 20,085 pounds, valued at $405. Compared with 1904, there was a decrease of 821, or 58.14 per cent, in the number of persons employed, of $721,937, or 34.41 per cent, in the investment, and of 1,451,681 pounds, or 70.94 per cent, in the quantity and $122,878, or 73.36 per cent, in the value of the products.

The number of persons engaged in the fisheries of Delaware was 976, the investment was $585,616, and the products amounted to 25,023,193 pounds, valued at $652,448. The principal species taken, in the order of their value, were oysters, 4,315,731 pounds, or 616,533 bushels, valued at $450,873; menhaden, 18,082,000 pounds, valued at $67,970; squeteagues, "sea trout," or weakfish, 886,550 pounds, valued at $53,317; croaker, 418,873 pounds, valued at $18,682; shad, 86,836 pounds, valued at $16,312; carp, 87,820 pounds, valued at $13,166; sturgeon, including roe, 13,962 pounds, valued at $6,952; and alewives, 351,590 pounds, valued at $6,431. Compared with 1904, there was a decrease of 923, or 48.60 per cent, in the number of persons employed, and of $84,379, or 12.59 per cent, in the investment, but an increase of 19,414,904 pounds, or 346.18 per cent, in the quantity and $392,858, or 151.53 per cent, in the value of the products.

SHAD FISHERY OF THE HUDSON RIVER.

The shad fishery of the Hudson River in 1921 had engaged 307 persons, the investment was $44,607, and the catch was 35,448 shad in number, or 130,803 pounds, valued at $30,623. Of this quantity 28,948 shad, or 104,883 pounds, valued at $24,329, were taken in New York, and 6,500, or 25,920 pounds, valued at $6,294, in New Jersey. Compared with 1920, there was a decrease of 61 persons, and of 13,867 shad, or 69,041 pounds, and $25,706 in the value, but an increase of $4,256 in the investment.

In 1922 there were engaged 272 persons, the investment was $40,342, and the catch was 48,336 shad, or 175,186 pounds, valued at $39,706. The catch in New York was 36,111 shad, or 128,324 pounds, valued at $27,451, and in New Jersey, 12,225 shad, or 46,862 pounds, valued at $12,255. Compared with 1920, there was a decrease of 96 persons, and of 979 shad, or 24,658 pounds, and $16,603 in the value, with practically no change in the investment.

FLORIDA SPONGE FISHERY.

The quantity of sponges sold at the Sponge Exchange, Tarpon Springs, Fla., in 1922, was 526,885 pounds, valued at $699,092. This total included large wool sponges, 248,475 pounds, valued at $596,199; small wool, 70,478 pounds, valued at $42,286; yellow, 115,455 pounds,

valued at $37,637; grass, 84,892 pounds, valued at $20,379; and wire, 7,585 pounds, valued at $2,588. It is estimated that sponges to the value of $50,000 were sold at Tarpon Springs outside of the exchange. Information as to the quantity sold at Key West is not available but is known to be comparatively small.

INQUIRY RESPECTING FOOD FISHES AND FISHING GROUNDS.

INTRODUCTION.

The effect of the gradual development of the fisheries of the United States has borne unequally upon the several resources exploited, partly as a result of the intensity with which the fisheries have been prosecuted in relation to the abundance of the original supply, partly owing to peculiarities in the distribution and life histories of the several species, partly as the consequence of ruinous methods of fishing or wanton and short-sighted destruction, and partly as an inevitable sequence of the social, industrial, and commercial development of the country and the consequent modification of the character of the waters. Certain species like the sturgeon have become almost extinct commercially, the natural oyster beds in some originally richly endowed areas have been depleted or destroyed, the Atlantic salmon has become hardly more than a memory in the United States, the shad runs in almost all streams are sadly reduced, the salmons of the Pacific Coast States and Alaska are no longer able to support the fisheries of former years, and in some places are on the verge of economic extinction, and the halibut banks of the western Atlantic have been reduced far below their pristine productivity, and those of the north Pacific Ocean are following the same course.

The resources that have been more particularly affected are those that are fixed to the bottom or have limited powers of locomotion, those that are confined to circumscribed bodies of water, or that run into such waters for spawning or other purposes at certain seasons of the year, or those that mature slowly and are represented by comparatively few individuals of large size.

On the other hand, there are many fishes, particularly marine species, some of them of paramount economic importance, that show no indications of depletion. These are mainly species of wide distribution, abundance, and high reproductive capacity and that at no time congregate in narrow waters where they come under the control of the activities of man as exhibited by fishing operations or obstruction, pollution, or other alteration of their accustomed environment. It does not follow, however, that because no evidences of depletion have been detected it can be assumed certainly in all cases that it has not begun, or that it may not occur as the cumulative result of existing operations and conditions or future developments.

The correction of existing and the prevention of prospective depletion has been sought principally through the agency of fish culture and legislation more or less restrictive of fishing operations and practices. It is obvious that a foundation for these measures must be established on an accurate and reasonably complete knowledge of the life histories of the organisms with which they deal, as otherwise they may prove wasteful and ineffective while at the same time im-

posing futile obstacles to the development of a legitimate and essential industry. The work of the division of scientific inquiry of the bureau is directed to the acquisition of this knowledge and its adaptation to the needs of the fisheries, its principal activities during the fiscal year being epitomized in the following pages.

STUDIES OF FISHES.

The salmon fisheries of Alaska present the most critical problem of fishery conservation confronting the bureau at the present time, the intensity of the fishery developed during recent years having very seriously depleted the runs in some streams, while almost everywhere the diminution has made itself manifest to a degree threatening eventual disaster. As is explained in more detail elsewhere in this report, the laws under which the bureau has been endeavoring to conserve this fishery are inadequate, and it has been necessary to invoke the powers of the President to create fishery reservations to give the immediate control of the situation necessary to save the fish.

While studies made during the past decade have added much to knowledge of the habits and life histories of the Pacific coast salmons, their wide distribution from California to the Arctic, the differences in environment through their range, and the fact that practically each stream has its own exclusive school of fish, makes their study laborious, time-consuming, and difficult. With the purpose of preparing a sound basis for regulatory measures that will conserve the fish while permitting the maximum safe exploitation of the fisheries, the bureau for a number of years past has engaged specialists to conduct the necessary investigations.

The enumeration of the salmon passing into Karluk River, on Kodiak Island, which has been referred to in previous reports, was continued during the year and a similar work was undertaken at Chignik. These studies are intended to furnish data of the ratio of fish on the spawning grounds to the total run necessary to maintain an unimpaired supply.

In an effort to determine the composition of sea schools of salmon in respect to the location of their spawning streams, about 4,000 adult fish were marked with aluminum tags at various places on or near the Alaska Peninsula. A considerable percentage of these was retaken, and valuable data were obtained regarding the oceanic migrations of the fish. This work will be supplemented and extended by tagging about 10,000 fish during the fiscal year 1924. A report on the progress of these studies was published during the year. Since 1916 nearly 750,000 young salmon have been marked by cutting off various of the fins and liberating them in the Columbia, Sacramento, and Quinault Rivers. On their return to the streams after several years spent in the sea these fish are easily recognized. During the spring of 1920, 100,000 young sockeye salmon, reared from eggs brought from Alaska in 1918, were so marked and liberated in the Columbia River with the invaluable cooperation of the Oregon Fish Commission. In 1922 large numbers of these, grown to maturity, returned to the river, and scales and data from approximately 1,200 were obtained. This, of course, does not represent the number entering the river. The fish, both in external appearance and qualities of flesh, retained the char-

acters of their Alaskan ancestry, being distinctly different from native Columbia River fish of the same species.

Many of the important former spawning grounds of the blueback salmon of the Columbia River have been made inaccessible by the construction of power and irrigation works, and in 1922 an investigation was made to locate the spawning places now resorted to. It was found that a spawning run progresses at least to Sunbeam Dam on Salmon River, Idaho, and that the improvement of the fishway at that place to make it more readily passable to fish bound for Redfish Lakes should be undertaken.

The investigations on the Coregoninæ, or whitefishes, which are among the most important commercially of the Great Lakes, have been continued; the field work was completed early in the fiscal year, and the attention of the investigators has been directed for some months to the examination and comparison of collections and the compilation of data to be included in the final report on the systematic relations and natural history of the various species. Many data bearing on the differences between various races of whitefish and other coregonine fishes are now available, and especial attention is being given to the life history of the whitefish. The University of Michigan and the State Biological Survey are evincing a fine spirit of cooperation, which will materially aid and advance the work.

For a number of years the bureau made investigations, as opportunity occurred, of the salmons, trouts, and smelts of the Atlantic coast, but the work was suspended in 1921 on the resignation of the assistant who had been conducting it. It was resumed during 1923 on the return of the investigator to the service, and considerable progress has been made in assembling the accumulated data for publication. Some light has been thrown on the complicated relationships of the trouts, and material is on hand for clearing up certain puzzling matters of particular interest to fish culturists and anglers, but during the year attention has been devoted chiefly to smelts, which are important economically both as local food supplies, as entering into commerce, and as food for other fishes. As a consequence of the assiduity with which the smelt fisheries have been prosecuted, the supply of fish is being depleted gradually, and the report in preparation will be comprehensive of all facts relating to them that may be significant in efforts toward their conservation where still abundant and their increase in waters that have been depleted.

In cooperation with members of the faculty of the University of Wisconsin, studies of the natural foods of fresh-water fishes, particularly the basses, sunfishes, and perch, in wild waters, have been conducted with very small assistance from the bureau.

The available fisheries of interior waters and of the streams falling directly into the sea, as a whole, are now exploited to their permissible limits, and in some cases already mentioned are showing more or less marked indications of exhaustion. For increased production of fish food to meet the demands of growing population recourse must be had to that great reservoir of food, the sea. Of the strictly marine fishes none of the more important species, with the exception of the halibut, are exhibiting the criteria of depletion excepting, perhaps, locally; but with a conceivably possible but by no means imminent large increase in consumption, such symptoms may manifest

themselves on some of the banks and fishery grounds more adjacent to our coasts, and it is not impossible that they are already present obscurely. It will be highly important to recognize them promptly, that corrective measures may be taken before conditions become so critical as to require drastic action economically objectionable. For these reasons comprehensive investigations of important fishery areas north and east of Cape Cod were undertaken a number of years ago and continued to the present time, with an interruption of several years during the war.

The fundamental facts of the distribution of water temperatures and salinities, the horizontal and vertical circulation of the water, the resulting production and distribution of the primary foods of fishes, and the dissemination of their eggs and young have been determined more accurately than on any other part of our Atlantic coast. During the year the most important work in this connection has been the release of 1,500 drift bottles for current determinations in cooperation with studies of like character conducted by the Canadian Government in the home waters. Plans have been laid for supplementary work during the fiscal year 1924. Also, following a project of cooperation with Canada, 2,396 cod, haddock, and pollock were marked with metal tags and released, and the practice will be continued until a total of 10,000 fish has been so treated. This experiment is to elucidate the facts of the migration, growth, etc., of these important food fishes, and will be supplemented by other studies during the coming year that will develop the other information necessary for the formulation of conservation measures, which at any time may become necessary.

A correlated investigation during the year was the study of the seasonal changes of the plankton of the vicinity of Woods Hole, based largely on the collections made by the bureau's laboratory at that place over a long series of years. Plankton is composed of the floating plants and animals, mostly minute, which constitute practically the sole food of most marine fish fry and directly or indirectly the food of most of the adults. On it primarily depends the fish production of the sea.

During the year there was completed and submitted for publication a comprehensive report briefly describing all of the fishes known to occur in the Gulf of Maine and epitomizing what is known of their life histories. This work, and a large part of the other work of the bureau in that region during the past 10 years, has been made possible by the cooperation of the director of the Museum of Comparative Zoology at Cambridge, Mass., and Dr. H. B. Bigelow, of the same institution.

The field work of the investigation of the fisheries of Chesapeake Bay was completed in June, 1922; the collections and data have been consigned to specialists, and considerable progress has been made toward a comprehensive report on the region. This investigation repeats, in a more circumscribed area, the general features of that conducted in the Gulf of Maine. The U. S. Coast and Geodetic Survey, the U. S. Geological Survey, and the U. S. Weather Bureau have all cooperated by furnishing valuable data respecting the hydrography and meteorology of the Chesapeake basin.

OYSTER INVESTIGATIONS.

Oyster investigations in Long Island Sound and Great South Bay were continued during the year, the field work lasting from early in June until September 20.

The special purpose of the work in Great South Bay is to discover the cause of the great mortality which frequently occurs after an abundant "set" has apparently established the basis for a good crop. The presumption has been established that this is due to conditions peculiar to the bottom or the stratum of water near the bottom. Well-grown oysters of the set of 1921 were found in compact groups in various situations a few feet above the bottom, while all those that had set so abundantly on or near the bottom had died shortly after becoming attached. The work planned for the summer was the testing of various types of cultch that would permit a set above the danger zone, but this purpose was defeated by the exceedingly poor set of 1922, possibly due to unstable water conditions.

The investigations in Connecticut revealed that a much better than ordinary set followed a reasonably early spawning in harbor and inshore waters, lending some confirmation to the previous indications that failures of recent years have been due to the depletion of the inshore beds from overfishing and the results of pollutions. Oyster larvæ were found in Housatonic River, recently devoid of oysters, where some had been planted in the spring.

In cooperation with the Bureau of Chemistry a study was made of conditions in Housatonic River and New Haven Harbor in respect to trade pollutions from heavy metals, oxygen content, and alkalinity. One of the difficulties encountered in all of these investigations has been the lack of precise information regarding the pristine and present hydrographic and planktonic conditions. To furnish such data of the existing state of the waters, the *Fish Hawk*, under the direction of the naturalist of the *Albatross*, was detailed to make a survey of conditions that might bear on the mortality obtaining among the oyster fry and the spat after a brief period of survival. The field work was practically complete at the close of the fiscal year, with the exception of a few weeks' special study of inshore polluted areas.

INVESTIGATIONS RELATING TO FISH CULTURE.

The biological station at Fairport, Iowa, has continued its experiments in the culture of various of the important commercial fishes of the Mississippi Valley. The hatching and rearing of buffalo fish in ponds as an adjunct to the farm-food supply appears feasible, but it is doubtful if the species can be so produced on a commercial scale, owing to the large pond area required for attainment of maximum growth in large numbers.

The results of experiments with the channel cat have been sufficiently promising to warrant setting aside several ponds for the work, and at the close of the year the indications were that there would be justification for undertaking the work on a basis of practical magnitude next season.

The spawning habits of the paddlefish, a disappearing species particularly valuable for the production of caviar, are entirely un-

known, notwithstanding the work of a number of investigators. A number of young fish are now being reared at the laboratory, but they have not yet reached the spawning age.

The hackleback sturgeon is another highly prized fish likewise imperiled by the fishery as now conducted, and drastic control will be necessary if it is not to be economically exterminated. Unlike most fishes, the hackleback does not spawn annually. The rock sturgeon is in the same category with the hackleback in respect to its individual value and waning numbers, and both species have been the subject of study and experiment for the development of practical regulatory and fish-cultural measures for their conservation.

The bureau's fish pathologist has been engaged principally in the investigation of certain diseases that have produced serious losses of fish at various hatcheries and during distribution of the young. One of the most widespread and destructive of these maladies affecting trout was found to be due to an intestinal parasite (*Octomitus salmonis*) which causes fatal enteritis. No means for directly combating this disease have been developed, but palliative measures, such as the avoidance of overcrowding and the maintenance of a lower water temperature during transportation, have decreased the mortality.

The brood stock of bass and, to a minor degree, other pondfishes at Neosho (Mo.) station has developed from time to time numerous cases of sterility, which have seriously curtailed the output of the station. An investigation during the past year has shown this to be due to an ovarian infection by the larvæ of a tapeworm.

During the latter part of the year a series of experiments for developing a more satisfactory diet for trout was inaugurated at the hatchery at Manchester, Iowa, and the laboratory at Fairport, Iowa, under the direction of the fish pathologist. In the light of present knowledge of mammalian nutrition, to which much attention has been directed in recent years, it appears that the foods now used in hatcheries may be deficient in certain essential constituents, particularly vitamines and salts. It is not improbable that these deficiencies may contribute to the troubles encountered by fish-culturists, and it is hoped that a more fully adequate ration can be devised as a result of the current investigation.

The pathologist and several members of the staff of Fairport laboratory have made a number of investigations of epidemics occurring both in wild waters and in State and private hatcheries.

FRESH-WATER MUSSELS.

Investigations and experiments relating to the pearl-button mussels of the Mississippi River drainage system have been continued in the interests of improvement in the methods of mussel culture and other essentials for the conservation of these economically important mollusks.

Studies of the factors affecting the survival and growth of juvenile mussels after they have passed the parasitic larval stage have been attended with results warranting the establishment of a small rearing system, consisting of 150 metal troughs with a capacity of about 750,000 mussels, an important feature of which is the exclusion of light. The indications are that more tangible and better-

controlled results will accrue from this method than are now attained by the infection of fish liberated in the open waters with all the attendant uncertainties as to the fate of the little mussels dropped fortuitously.

Statistical and biological surveys have been conducted during the year in Lake Pepin and Lake Pokegama, in both of which mussel culture has been carried on for several years. In Lake Pepin there has been also an alternate sectional closure to commercial mussel fishing. The survey of Lake Pepin indicates that there has been an increase in the commercially important mucket (*Lampsilus luteola*), propagated by the bureau, while the other species not propagated have decreased. The facts developed in this survey are the most conclusive evidence of the value of mussel culture so far obtained.

The personnel of the Fairport laboratory has been active in assisting the State authorities in developing rational legal measures for the conservation of the mussel beds, as a consequence of which the States of Minnesota, Iowa, Wisconsin, and Illinois have entered into cooperative closure of alternate sections of the Mississippi River between Brownsville, Minn., and Keokuk, Iowa, and Arkansas has announced the intention to pursue the same system of regulation on the Black and White Rivers.

MOSQUITO CONTROL.

Investigations relative to mosquito control by means of fish, particularly the top minnow Gambusia, were continued at Augusta, Ga., from July 1 to November 10, in cooperation with the U. S. Public Health Service.

The problems under immediate consideration were the effects of various types of vegetation on mosquito production; the effects of increased competition for food among Gambusia upon the rate of mosquito production; sex frequency and the relative vitality of the sexes of Gambusia; and the proper treatment of the fish in captivity and under shipment.

Tests made with various types of vegetation, including some that have been considered inimical to mosquito production, show that few, if any, of them prevent mosquitoes breeding, but that many species of plants do not form barriers between top minnows and mosquito larvæ and are therefore neutral in their effects on mosquito production in waters containing the minnows. It was shown also that it is not always the dense vegetation, as is commonly believed, that forms the best protection for mosquito larvæ against fish.

Competition for food among Gambusia is advantageous, and even in the presence of a serious barrier complete mosquito control may be approached if sufficient minnows are present. The observations on the vitality of the sexes indicated that the males succumb more easily than the females.

Under shipping conditions Gambusia lived equally well in vessels of the same diameter when only one-third full of water as they did when the vessels were filled two-thirds full, and tests indicate that shipments can be made most successfully when the temperature of the water ranges from 83° F. downward. During December, 1922, 200 Gambusias were shipped to Palestine with a loss of but 30 en route.

During the year two rather extensive trips were made by the assistant in charge of the investigation to various sections of the Southeastern States for the purpose of inspecting malaria-control projects and to offer suggestions to local health officers concerning the proper use of mosquito-destroying fish. The annual conferences of the National Malaria Committee and the field men conducting malaria-control work were attended.

FOULING OF VESSEL BOTTOMS.

In September, 1922, at the request of the Navy Department, the bureau undertook direction of an investigation of the marine growths on the bottoms of ships to determine, if possible, the conditions governing the amount and character of such growths and the possible seasonal and regional factors affecting them, with a view of securing data on the problem of preventing their attachment to ships' bottoms, as well as to determine the docking intervals for ships in various kinds of service.

The investigation has also indicated, rather conclusively, that most of the fouling occurs while the ships are in harbors and that vessels in commission that never stay more than six or seven days in any port and that travel between ports a considerable distance apart do not foul seriously, at least during August to March, in the North Atlantic Ocean. On the other hand, it is found that vessels that lie continuously at anchor in any one port for the five or six winter months become heavily coated with hydroids but not with barnacles.

Cooperation has been extended to the Navy Department in testing the relative efficiency of various antifouling paints.

MISCELLANEOUS INVESTIGATIONS IN INTERIOR WATERS.

Cooperation has been continued with the Wisconsin Geological and Natural History Survey in important investigations of the fundamental conditions of fish life in lakes. The aquatic plants, the plankton, bottom fauna, and mussels of Green Lake were studied during the past year with reference to quantity and distribution. Arrangements have been made for the continuance of these investigations during the fiscal year 1924.

In cooperation with the Illinois Natural History Survey, the Chicago Drainage District, and the U. S. Public Health Service, a statistical survey of the Illinois River for 1921 was made by members of the staff of the Fairport Biological Station in connection with a study of the effects of pollution and the reclamation of land along the stream upon public health, recreation, agriculture, and the fisheries.

During the summer of 1922, in cooperation with the National Park Service, the bureau made an investigation of the pelicans in the Yellowstone National Park to determine their destructiveness in relation to the trout, the supply of which the bureau helps to maintain by artificial propagation. The results of this investigation indicate that the pelican is a highly specialized predatory bird, and that its breeding period in the park is so precisely synchronized with that of the trout that its depredations effect maximum losses. It was originally suggested that attention be directed rather definitely to the problem presented by the parasites of the pelicans and of the trout

in Yellowstone Lake. Some data were secured on this point, but the general problem of the destructiveness of the birds with respect to the trout, after conferences on the ground, was considered to be of such immediate importance that the question of parasites was temporarily relegated to the background and has not been the subject of special attention.

OPERATION OF BIOLOGICAL LABORATORIES.

The biological laboratory at Fairport, Iowa, has been operated as usual, conducting investigations and experiments in the interests of the economic aquatic resources of the Mississippi Valley and practical fish culture and mussel culture as an aid to their conservation. The more important activities have been mentioned briefly in their appropriate places in preceding pages of this report.

The laboratory at Woods Hole was operated during the summer with a small staff of the bureau's employees, and its facilities were extended, at no additional expense, to a number of independent investigators making studies of various problems of marine biology. During the remainder of the year it was used as a base for the staff of the *Albatross*, who were engaged in investigations of the basic food organisms of the region and in the oceanographic and biologic studies mentioned in connection with the investigation of the causes of the disastrous conditions obtaining in the oyster industry in Long Island Sound and contiguous waters.

There is still an almost complete lack of personnel at the Beaufort (N. C.) laboratory, due to the impossibility of filling the vacant positions with competent men at the salaries available. The work on diamond-back terrapin culture made some progress, and the facilities of the laboratory were profitably employed during a large part of the year by investigators of the Navy Department employed in the study of fouling of ships' bottoms. During the summer of 1922 several independent investigators made use of the laboratory. Repairs have been made to buildings, sea wall, and grounds, and the station is in satisfactory physical condition.

The situation at Key West (Fla.) laboratory is also unsatisfactory in respect to personnel for the same reasons as at Beaufort. Some improvement in the buildings and grounds were made during the year, but the incomplete condition of the station and the lack of personnel render it nearly unproductive at present.

POLLUTION OF WATERS.

The bureau's recommendation of a small appropriation for the systematic study of water pollutions in their relation to the fisheries failed to receive the favorable consideration of Congress, and this important subject has received practically no attention during the year excepting as a part of the investigation into the conditions causing the failure of the oyster set in Long Island Sound. I feel that I can not do better than reiterate the statement carried by my report of last year:

> Pollution of interior streams and waterways by industrial wastes and municipal sewage has been the subject of complaint and protest for many years. Industry itself frequently has been a victim of its own acts through inability to use the polluted water with safety in boilers or for the many other industrial purposes that require pure water. The public health has been menaced, public works have been damaged, agriculture has suffered, and in some parts of the country the streams have been swept bare of living things, including

fishes and other animals of economic importance. Recently the vast development of petroleum production and transportation, the use of its derivatives for manifold purposes ashore, and particularly as fuel on ships, has introduced a new element of serious pollution in the great harbors and in places on the open coast.

The pollutions are almost as varied as industry and in many cases are not only complex in themselves but are further complicated by their reactions on one another and on the natural constituents of the waters themselves. The waters can not be restored to their pristine purity, nor to any state approaching it, by mere legislative fiat, and the sooner that fact is appreciated and constructive measures are taken the better for the public welfare.

The pecuniary losses now suffered as the result of water pollutions are enormous, and the preventable damage to the life and beauty of our streams, lakes, and seacoast is beyond estimate in terms of mere money. If existing abuses are to be corrected and new ones prevented without inflicting widespread economic injury, something more constructive than drastic laws must come into being. There must be corrective legislation, but it should be based on something more substantial than a perfectly justifiable desire for improvement. Complete utilization of raw materials is an ideal not attainable. Industry must be accompanied by "waste," and the wastes must be disposed of in some manner. The problem is to devise ways of disposing of them so as to minimize their harmfulness while still permitting industrial development. This is the problem of the biologist, the chemist, and the engineer working in cooperation.

The effects of these pollutions on the fisheries are the only phases of the subject that officially concern the bureau, and it has continued to endeavor, so far as its means would permit, to contribute to the solution of the problems involved; but it is futile to expect that much can be done unless money and, particularly, trained and capable men are provided for the purpose of determining facts and their practical and scientific implications.

PROPAGATION AND DISTRIBUTION OF FOOD FISHES.

REVIEW.

During the fiscal year 1923 the fish-cultural operations of the bureau were conducted along the same lines as in 1922. Work at some of the more remote substations had to be discontinued owing to insufficient funds, particularly on the Pacific coast, where it is the practice to operate widely scattered field stations on or near the spawning grounds in order to supply the salmon hatcheries with their full quota of eggs. No attempt was made to collect eggs of the pike perch and yellow perch at the Bay City (Mich.) or the Swanton (Vt.) substations. In the marine fish-cultural field the usual offshore work of collecting and fertilizing eggs of the cod, haddock, and other commercial species, and immediately returning them to the natural spawning grounds, had to be omitted.

The Green Lake (Me.) station was closed at the beginning of the fiscal year by authority of Congress, on the recommendation of the bureau. Fish-cultural work at this station has been handicapped by the nature of the water supply, taken from a large open pond, which frequently during the early spring months attained a temperature too high for trout rearing, thus necessitating the premature planting of all stock on hand. In view of the limitations imposed on the work by these conditions, and the very appreciable increase in the cost of maintaining and operating the station within recent years, it was deemed advisable to close it.

Generally speaking, conditions were not favorable to fish culture during the year. Low-water stages on the west coast interfered with the run of fish in many of the streams early in the season, only to be followed later by heavy floods, which in some instances carried away the racks and permitted the escape of the brood stock held

below. A large number of lake-trout eggs were taken, but adverse weather during the spawning season curtailed the collections of whitefish and cisco eggs.

In the Lake Erie field pike-perch propagation was seriously curtailed by the late spring and the large accumulations of ice remaining on the spawning grounds beyond the usual time. On the other hand, a remarkably good showing was made in the propagation of carp at Port Clinton, Ohio. The carp fishery of this region is an important industry, yielding an annual product valued at approximately a million dollars, and the local fishermen are very appreciative of the bureau's efforts to maintain the supply. As a result of their hearty cooperation, the collection of eggs last season was the largest ever made by the bureau. The fishermen take carp in large numbers in the course of their ascent of the Portage River during the spring to spawn and transfer them to ponds from 5 to 15 acres in area, where they are held and fed on shelled corn until September and are then shipped alive to the New York markets. The buffalofish, a species which the commercial fishermen regards as more valuable than the carp, was introduced into the Portage River by the bureau several years ago and appears to have become established there.

A successful season was experienced in the collection of buffalofish eggs in Louisiana, but owing to pollution of the water supply from floods in the Ouachita River, very heavy losses were sustained during the incubation period, thus reducing the output. The bureau received considerable assistance in the collection of the eggs and the distribution of the fry through the cooperation extended by the Louisiana Conservation Commission.

The collection of cod eggs on the Atlantic coast was the largest ever made by the bureau, but there was a considerable reduction in the output of other species from the marine hatcheries owing partly to adverse natural conditions during the spawning season and partly to lessened activities of the commercial fishermen on account of the low market prices prevailing for the species in question during the spawning period.

Shortage of funds necessitated the omission of the usual purchase of adult Atlantic salmon as a source of egg supply for the Craig Brook (Me.) station. Thus far the Penobscot River fishermen have refused to cooperate with the bureau on a reasonable basis in its efforts to maintain the supply of salmon in that river, and unless they can be prevailed upon to adopt a more favorable attitude a large measure of success can not be expected. It is essential that the fishermen turn over brood fish to the bureau at the prevailing market price without requiring a bonus for handling, as at present. The maintenance of the salmon supply in this region is of far greater importance to the local fishermen than to anyone else, and they should lend the bureau a reasonable amount of assistance in connection with its efforts in their behalf.

The shad-spawning season on the Potomac River was unusually late, no eggs being available until near the end of April, fully three weeks beyond the usual time. Scarcity of snow, slight rainfall, and unseasonably low temperatures undoubtedly had their effect in delaying and shortening the spawning period. Shad are extremely sensitive to the temperature and quality of water, and they will enter those streams only where the conditions are favorable.

As will be noted from the summary of distribution, the output of fingerling fish of all species was 35 per cent smaller than that of the previous year. This is largely accounted for by the smaller number of rescued fish handled as compared with that year. Shortage in the general propagation fund also had its effect upon this branch of the work, as large numbers of young fish can not be reared without involving considerable expense for food and labor.

During the fiscal year 1923 fish-cultural work was conducted by the bureau in 33 States and in the Territory of Alaska, involving the operation of 37 main stations and 32 auxiliaries, and the propagation of over 40 species of food fishes. Consignments of eyed eggs of certain species were furnished on request to several foreign Governments, and in numerous instances allotments of eggs were transferred to State hatcheries and other stations of the bureau as an economical and efficient means of rehabilitating depleted waters.

The bureau does not transfer eggs or fry of the important commercial fishes to points remote from the source of collection, as the entire available supply is needed for the maintenance of the fisheries in home waters. This applies especially to the Pacific salmons, to the whitefish, lake trout, and pike perch of the Great Lakes region, and to the shad and the marine species of the Atlantic coast.

Summary, by species, of the output of fish and fish eggs during the fiscal year ended June 30, 1923.

Species.	Eggs.	Fry.	Fingerlings.	Total.
Catfish			37,092,979	37,092,979
Buffalofish	163,169,500	5,925,000	9,429,838	178,524,338
Carp	29,000,000	115,000,000	14,226,110	158,226,110
Shad		16,971,000		16,971,000
Glut herring		150,000,000		150,000,000
Whitefish	148,041,000	208,675,000	3,000	356,719,000
Cisco	10,000,000	39,000,000		49,000,000
Chinook salmon	4,205,000	720,000	28,965,045	33,890,045
Chum salmon		8,274,830	14,997,900	23,272,730
Humpback salmon		396,950	1,915,435	2,312,385
Silver salmon	100,000	8,371,025	5,910,630	14,381,655
Sockeye salmon	10,678,400	31,582,000	50,949,400	93,209,800
Steelhead salmon	1,744,000	275,000	5,339,005	7,358,005
Atlantic salmon		451,000	40,038	491,038
Landlocked salmon	76,872	727,670	92,800	897,342
Rainbow trout	2,689,960	754,000	3,408,159	6,852,119
Black-spotted trout	10,127,100	2,160,100	1,492,700	13,779,900
Loch Leven trout			43,800	43,800
Lake trout	7,253,300	34,748,415	232,080	42,233,795
Brook trout	725,300	2,841,400	8,477,250	12,043,950
Smelt	16,280,000	28,000,000		44,280,000
Pike and pickerel			905,395	905,395
Crappie			35,602,522	35,602,522
Largemouth black bass		806,500	1,342,349	2,148,849
Smallmouth black bass		449,400	79,007	528,407
Rock bass			64,035	64,035
Warmouth bass			8,350	8,350
Sunfish			26,854,257	26,854,257
Pike perch	37,275,000	63,365,000		100,640,000
Yellow perch	3,680,000	136,325,000	936,295	140,941,295
White perch			675	675
Striped bass		16,341,000		16,341,000
White bass			40,085	40,085
Fresh-water drum			49,026	49,026
Cod	650,980,000	376,813,000		1,027,793,000
Haddock	104,400,000	2,960,000		107,360,000
Pollock	33,960,000	276,098,000		310,058,000
Flounder	229,345,000	1,058,781,000		1,288,126,000
Miscellaneous fishes			15,818,142	15,818,142
Total	1,463,730,432	2,586,812,290	264,316,307	4,314,859,029

DISTRIBUTION OF OUTPUT OF HATCHERIES.

As heretofore, the fish and fish eggs produced at the bureau's stations were widely distributed, the output of commercial fishes being liberated as fry in suitable public waters, while the various species adapted for interior ponds, lakes, and streams were assigned on applications submitted by individuals, organizations, and State fisheries authorities. Shipments were made to practically every part of the United States, the coastal regions of Alaska, and to several foreign countries.

The five specially equipped cars of the bureau are used principally for the distribution of fishes to interior waters, including both public and private ponds, lakes, and streams, for which individual applications have been submitted, and waters within the United States forest reservations and national parks. In addition, the cars are employed to some extent in shipping fry from the Great Lakes hatcheries to distant spawning grounds that can not be reached conveniently by boat. In all other cases the distribution of the commercial species is accomplished without the use of the cars, most of the fish being liberated on spawning grounds in the immediate vicinity of the hatcheries.

During the fiscal year 1923 the bureau's cars and messengers covered 415,505 miles of travel on regular passenger trains, in the course of which 11,500 applications for fish were filled. Of this total, 70,118 miles were traveled by the cars and 345,387 miles by detached messengers.

In a number of instances the bureau refused to entertain applications for such spiny-rayed fishes as bass and pike for introduction into waters connected with the salmon streams of the west coast, on the ground that such fishes would be certain to prove destructive to the existing valuable fisheries of that region. If placed in such waters, the young of these predatory fishes would almost certainly eventually ascend the salmon and trout streams to the natural spawning grounds, prey upon the eggs and young of the indigenous species, and destroy their nests.

The bureau has also found it necessary to refuse trout and smallmouth black bass for stocking waters in the South, where the temperature becomes too high for these fishes. It also refuses to furnish bass and other warm-water fishes for introduction in rivers and lakes where these species are indigenous and already abound. Many persons submit applications for fish without considering the necessity. If the fishing happens to be poor they apparently think that the mere planting of fresh supplies of fish will afford a bountiful stock. In any event, it is easier to ask for " something for nothing " than to exercise care and vigilance in the conservation of that which already exists. In such cases the essential requirement is not additional plants of fish but adequate protection for the existing stock during the spawning season and the application of proper restrictive regulations during the remainder of the year. If well protected, most of the warm-water fishes will maintain themselves and multiply without other assistance where the conditions are congenial. The demands for fish for depleted waters throughout the country are so great as to tax the resources of the bureau, and it can not under-

take to furnish stock for waters that need nothing but reasonable protection to restore them to full productivity.

RELATIONS WITH STATES IN FISH CULTURE.

To meet the heavy demands by tourists and automobile parties upon the fishing in the waters of many States, the State authorities have had either to increase the production at their own hatcheries or to work in closer harmony than heretofore with the bureau. The cooperative relations thus established have been beneficial to both parties and in many instances have resulted in more economical and efficient work than would otherwise have been possible.

In several parts of the country eggs are collected conjointly by the bureau and the State fish commissions. In some instances the bureau's personnel is lent to the State authorities for the development of egg-collecting fields with the understanding that an equitable division of the eggs or the resulting fry will be made. In the southern districts of the Mississippi Valley young fish are removed from more or less inaccessible waters, where they are crowded together in large numbers and serve only as prey for larger fish, and are placed in a more suitable environment, that they may eventually be of benefit to the public. In the upper Mississippi Valley assistance is rendered by the neighboring States in transferring fish from landlocked pools to tributary waters of the Mississippi River where favorable conditions exist. In several cases surplus eggs have been exchanged by State organizations and the bureau with advantage to both parties.

With the increasing demand for fish other cooperative relations between the bureau and the States have assumed larger proportions. The bureau is constantly calling the attention of various State officials to the necessity for more adequate laws for the protection of the food and game fishes within their boundaries. At the present time legislation of this character is lacking to a greater extent in the Southern States than in any other part of the country. The fisheries of the South have not as yet become so depleted as in many parts of the North, and, owing to the natural productivity of southern waters, the need for protective legislation has not become so imperative. However, the large influx of tourists to the Southern States during the winter months is rapidly changing the situation and unless these States adopt measures for the protection of fish, particularly during the spawning season, their waters will soon be in a state of depletion. Not only are the laws inadequate but very few States in this region make any additions to the existing stock by the introduction of fish produced at their own hatcheries.

The cooperative relations that have heretofore existed between the bureau and the Canadian fisheries authorities have been continued. Every year the bureau's station at Cape Vincent, N. Y., collects large numbers of whitefish and cisco eggs on the Canadian side in the Bay of Quinte, and not only turns over a portion of such collection to the Canadian hatcheries but also liberates in Canadian waters a certain percentage of the fry produced. The bureau has also received from the Canadian authorities consignments of Atlantic-salmon eggs and has returned in exchange eggs of the rainbow, brook, and blackspotted trout. This cooperation between the two countries has

resulted in each case in a greater output of fish than would otherwise have been possible and has led to the introduction of species that were especially desirable or necessary for the maintenance of existing fisheries.

During the fiscal year 1923 the fisheries authorities of 26 States were supplied with fish or fish eggs, as is shown in the following table:

Assignments of fish and fish eggs to State and Territorial fish commissions, fiscal year 1923.

[Asterisk (*) denotes eggs; dagger (†) fry; all others are fingerlings.]

State and species.	Number.	State and species.	Number.
Alaska:		New Jersey:	
Brook trout	*50,000	Rainbow trout	*100,000
Sockeye salmon	*5,098,936	Sunfish	88
California:		New Mexico:	
Black-spotted trout	*100,000	Blackspotted trout	*50,000
Lake trout	*100,000	Do	62,000
Colorado: Lake trout	*50,000	Brook trout	*300,000
Connecticut: Lake trout	*30,000	Rainbow trout	*69,500
Hawaii:		New York:	
Blackspotted trout	*50,000	Lake trout	*1,250,000
Rainbow trout	*25,000	Whitefish	*31,885,000
Idaho:		North Dakota:	
Blackspotted trout	*125,000	Black bass	400
Brook trout	900	Buffalofish	1,110
Catfish	1,500	Catfish	9,600
Rainbow trout	4,500	Crappie	5,550
Whitefish	*1,000,000	Sunfish	1,330
Iowa:		Yellow perch	1,100
Lake trout	*75,000	Ohio: Pike perch	*37,275,000
Rainbow trout	*153,600	Oklahoma: Rainbow trout	119,151
Louisiana:		Oregon:	
Black bass	24	Blackspotted trout	*50,000
Buffalofish	†1,200,000	Chinook salmon	*4,000,000
Crappie	250	Sockeye salmon	*5,045,000
Sunfish	1,700	Steelhead salmon	*370,000
Maine: Lake trout	*50,000	Pennsylvania:	
Maryland:		Rainbow trout	*681,000
Brook trout	750	Whitefish	*28,000,000
Chinook salmon	*15,000	Utah:	
Do	†4,000	Catfish	28,400
Crappie	100	Lake trout	*150,000
Humpback salmon	†3,350	Vermont:	
Rainbow trout	400	Lake trout	*130,000
Do	*114,000	Landlocked salmon	*20,349
Whitefish	*192,000	Steelhead salmon	8,000
Michigan:		Washington:	
Cisco	*10,000,000	Sockeye salmon	*534,464
Lake trout	†636,000	Steelhead salmon	*95,000
Minnesota:		Do	50,000
Black bass	600	West Virginia:	
Catfish	12,700	Brook trout	352,000
Crappie	17,900	Rainbow trout	500,000
Lake trout	*200,000	Wisconsin:	
Sunfish	7,520	Black bass	8,350
Yellow perch	100	Catfish	16,150
Missouri:		Crappie	7,800
Rainbow trout	*50,000	Lake trout	*3,000,000
Yellow perch	*3,680,000	Do	†1,760,000
Montana:		Wyoming:	
Blackspotted trout	*1,599,000	Blackspotted trout	*550,000
Lake trout	*50,000	Do	†300,000
Steelhead salmon	*100,000	Lake trout	*150,000
Whitefish	*1,000,000	Rainbow trout	*309,000
New Hampshire:			
Chinook salmon	*120,000	Total	*138,112,198
Lake trout	*50,000		†3,903,350
Landlocked salmon	*20,349		1,219,973

Shipments of fish eggs to foreign countries, fiscal year 1923.

Country and species.	Number of eggs shipped.	Country and species.	Number of eggs shipped.
Argentina: Steelhead salmon	25,000	Germany: Rainbow trout	68,000
Canada:		Netherlands:	
Blackspotted trout	317,000	Chinook salmon	200,000
Steelhead salmon	400,000	Rainbow trout	50,000
Whitefish	44,000,000		
Czechoslovakia: Rainbow trout	100,000	Total	45,160,000

COOPERATION WITH FISH-PROTECTIVE ASSOCIATIONS.

Throughout the year the bureau has worked in close harmony with fishing clubs and other organizations interested in stocking certain waters or in securing legislation for their protection. Such organizations have assisted in the distribution of fish by promptly meeting shipments sent out by cars or detached messengers and carefully liberating them in the most suitable waters available. The bureau has furnished these agencies information as to the best methods of planting fish, and in some instances public talks have been given by the bureau's representatives explaining its work at some length. In other instances the bureau's employees have been detailed to give advice to State organizations, their expenses while thus engaged being borne by the State in question.

PROPAGATION OF MIGRATORY FISHES OF ATLANTIC RIVERS.

Owing to various unfavorable conditions, the season's results in shad propagation on the Potomac River and in the Albermarle Sound district were smaller than for several years past. At the Bryans Point station the unusually cold and stormy weather prevailing practically throughout the spawning season interfered with fishing operations, and the river water remained too cold to ripen the eggs and cause the fish to seek shallow waters to spawn until about two weeks beyond the usual time. Shortly after the middle of April egg collections were undertaken and continuously prosecuted until May 15, and 17,677,000 eggs were secured. Shad work at the Edenton station was practically negligible as a result of a recently adopted decision to issue no permits for the operation of gill nets on the usual spawning grounds. In past years gill nets have constituted the main source of supply for shad eggs for this station, but experience having shown that many of the fishermen were not complying with the terms of the license, its discontinuance was deemed advisable. The results of the season's work in the propagation of glut herring at the Edenton station were most encouraging, the egg collections being increased over last year's collections by approximately 200 per cent, notwithstanding the difficulty encountered in obtaining efficient spawn takers to handle the large numbers of fish available.

Eggs to the number of 313,000,000 were obtained and incubated at an average cost of $2.14 per 1,000,000. The propagation of this

species represents conservation of the highest type, since the eggs would be sent to the market in the fish and lost were it not for the bureau's intervention. In past years the fishermen of the region have appeared reluctant to cooperate with the bureau in furnishing eggs, but they now seem to realize the importance of the work and it is believed there will be no difficulty hereafter in obtaining an egg supply.

The Weldon substation, on the Roanoke River, was fitted up for striped-bass propagation as usual, but egg collections were discontinued at the height of the spawning season, as it was found that the large amount of trade waste discharged into the river from a local manufacturing plant was polluting the water and killing the fry liberated from the hatchery. The total egg collection amounted to 22,084,000. At the beginning of the spawning season the fishermen at this point were loath to cooperate in the collection of eggs on a fair basis, but this opposition was overcome after the situation had been fully explained to them.

The usual collection of adult Atlantic salmon at the Craig Brook (Me.) station could not be made, due to the washing away of the barrier at the Dead Brook inclosure, where it has been customary to hold the fish for several months awaiting the development of their spawn. Five hundred thousand Atlantic salmon eggs, received at the Craig Brook station from the Canadian Government in exchange for an equal number of trout eggs, produced 466,000 fry, all of which, with the exception of a small number reserved for rearing to the fingerling stage, were liberated in the Penobscot River and its tributaries.

It is believed that greater results than heretofore may be attained by rearing a comparatively small number of fish to the No. 2 or No. 3 fingerling stage before liberating, and this policy will be pursued in connection with any future operations with this species. It is probable, however, that Atlantic salmon propagation on the Penobscot will be entirely discontinued unless the fishermen of the region show a greater willingness than they have thus far shown to cooperate in the work.

PROPAGATION OF COMMERCIAL SPECIES OF THE GREAT LAKES.

The bureau's work in this region was concerned as usual with the propagation of such important commercial fishes as the lake trout, whitefish, pike perch, yellow perch, and carp. Most of the eggs obtained from these species are taken from fish caught for the market by the commercial fishermen and incubated in the bureau's hatcheries, the resulting fry being liberated on the natural spawning grounds. Owing to heavy storms, which prevailed practically throughout the incubation period, there was a considerable shortage in whitefish egg collections as compared with the previous year, and the quality of those secured was impaired by the quantities of slime and sediment carried in the water supply. On the other hand, the weather in the spawning fields where lake trout eggs are obtained was favorable, and the collections of that species exceeded those made in 1922.

In the eastern end of Lake Ontario the ciscoes, for some unknown reason, did not resort to the spawning grounds in the usual numbers. Especially was this true in the ordinarily prolific Bay of Quinte, the

catch of the commercial fishermen in that field being very much below the average. As a consequence the egg collections for the Cape Vincent hatchery were reduced far below the total of last year. The smaller than average collection of pike perch eggs in the Put in Bay field resulted from an unduly late fishing season, the setting of the fishermen's nets being greatly interfered with by the large bodies of ice that remained in the lake to a late period. The collection of carp eggs in the Portage River district was the largest ever made by the bureau. All the carp fishermen of this region are greatly interested in the success of the work and are cooperating heartily in the bureau's efforts to increase its egg collections.

PROPAGATION OF PACIFIC SALMONS.

In the Pacific coast and Alaska fields the collection of salmon eggs amounted, in round numbers, to 179,000,000, or approximately 50,000,000 less than were secured last year, this considerable shortage being due to unusual water conditions. In some of the streams where operations were conducted the water stages were so low as to prevent fish from entering, while in other fields the racks installed to intercept the run were carried away by floods, permitting the escape of brood stock upon which the stations were depending for their egg supply.

A successful season was experienced in the collection of sockeye salmon eggs for the Afognak (Alaska) station, 61,790,000 being secured. The steady increase in the yearly egg collections in this region since 1912, when the run of salmon was destroyed by the eruption of Mount Katmai, would seem to indicate beyond doubt the effectiveness of artificial propagation. With the view of obtaining some definite information along this line as a preliminary to extending the work if the conditions warrant, steps have been taken to make an annual count of the salmon passing up the Karluk River, the first count to be made during the current season.

At the beginning of the sockeye spawning season at the Yes Bay (Alaska) station the water stages were too low to permit of egg collections, the conditions in this respect remaining unfavorable up to the end of the first week in September. Eggs to the number of 25,000,000 were taken between that time and September 22, when the work was abruptly terminated by heavy rains, which flooded and carried away the racks, permitting the escape of brood fish estimated to contain at least 10,000,000 eggs. This station has been making a point of rearing large numbers of young salmon to the fingerling stage before liberating them, and in order to conduct the work as advantageously as possible has inclosed the outlet of a natural slough, which appears to make an excellent feeding ground. The Forest Service has cooperated with the bureau in this region by constructing a trail to connect the station with tidewater.

In the Washington field the floods were especially severe in the Quilcene River, on which the Duckabush and Quilcene hatcheries are located, the water remaining at a very high stage for several weeks during a critical period. The 1922 annual census of sockeye salmon descending through the weir at Quinault Lake, Wash., was concluded on September 13 of that year, the total count amounting to

248,935 fish. The annual count for 1923 began March 20, and between that time and June 30 the number passing above the weir aggregated 123,022, as compared with 199,489 for the corresponding period of the previous year.

In the Oregon field the racks and other collecting equipment were damaged considerably by floods, which were heavy enough to wash away the station site on the upper Clackamas River and to carry out 200 feet of the flume and crib of the intake at the Little White Salmon hatchery. The total egg collections in this field were approximately 27,000,000, as compared with 63,000,000 last year. Part of this falling off may be attributed to depletion resulting from the heavy fishing operations four years ago, though success in the collection of eggs of any of the Pacific salmons is largely dependent on local water conditions in the streams, regardless of other influences. It is probable that the large industrial dams constructed in recent years will greatly interfere with stream flow, as the water is impounded during the wet season for use during periods of slight rainfall. Deforestation also has a deleterious effect on fish-cultural operations, causing the rainfall to drain rapidly from the land and overflow the streams where work is being conducted.

The marine stations in New England experienced a considerable falling off in egg collections, the total of all species secured amounting to but 3,200,876,000, as compared with 3,955,314,000 taken last year. The shortage occurred principally in the propagation of the winter flounder and haddock, and was the direct result of the low-market prices prevailing for fish of these species, which curtailed the commercial catch from which eggs are obtained. On the other hand, cod eggs were plentiful, both at the Woods Hole and the Gloucester stations, the collections for the two hatcheries exceeding 1,279,000,000, or more than twice the number secured in 1922.

In the Gloucester field the conditions connected with the propagation of pollock were even more unfavorable than last year. There seemed to be an abundance of fish on the spawning grounds, but they were constantly shifting about and large numbers remained close to the bottom where the nets could not reach them. The catch of the commercial fishermen was, therefore, small, and the egg collections for the station were correspondingly reduced. Owing to the large amount of surface water entering the harbor, part of the cod eggs secured for the Gloucester station could not be successfully incubated in the hatchery and 277,500,000 were planted on the fishing grounds immediately after being fertilized.

The fish-cultural output of the Boothbay Harbor (Me.) station was confined to the winter flounder, efforts to secure eggs of the pollock, haddock, and cod being unsuccessful. Late in February the station employees undertook the collection of a brood stock of winter flounders but were hampered by the heavy ice fields and abundance of snow on the fishing grounds, very few fish and no eggs being obtained until late in March. Notwithstanding this serious delay, about 5,000 brood fish were captured, the first on March 20, and between that time and May 10, the end of the spawning season, 943,316,000 eggs were secured. Comparatively small results were yielded in the usually prolific Linekins Bay field, as most of the fish in that territory remained in water from 30 to 40 fathoms deep throughout the season.

At the Woods Hole (Mass.) station considerable difficulty wa experienced in securing a vessel equipped with a well for the trans portation of brood cod as a source of egg supply, the vessels for merly employed for this work having either been sold or lost. A small one suitable for the purpose was finally hired at Newport R. I., and, arrangements having been made with the various tra owners to supply cod, approximately 2,800 were transferred fron the fishing grounds to the station. These fish yielded 555,584,00 eggs, and 114,000,000 additional were obtained for the station b spawn takers operating in Cape Cod Bay. Due to unfavorabl weather conditions in the Waquoit Bay collecting field, the collec tion of winter flounder eggs for the Woods Hole station was th smallest in several years, only 369,865,000 being secured. The wor with this species was undertaken on January 16 and complete April 4.

CULTIVATION OF FISHES OF INTERIOR WATERS.

Collections of eggs of the brook, rainbow, blackspotted, and Loc Leven trouts at the various stations devoted to work with thes species amounted, in round numbers, to 47,349,000, or 8,823,000 i excess of those collected in 1922. The increase in output over tha of last year was even greater, due to smaller losses sustained durin the incubation and rearing periods.

A very successful collection of brook-trout eggs was made for th Leadville (Colo.) station, but there was a falling off, compared wit the previous year, in the percentage of hatch. In accordance wit the usual custom, 500,000 of the eyed eggs were forwarded to th Bozeman (Mont.) station, with the view of utilizing the resultin fry in stocking suitable waters in the Glacier National Park.

During the month of November the force attached to the Spring ville (Utah) station, in cooperation with employees of the Uta State fisheries department, collected 8,250,000 brook trout eggs i Fish Lake, of which the station received 3,200,000 as its share. Th egg collections at this lake have shown a steady increase ever sinc the work was inaugurated by the bureau in 1917, the number take that year being 2,785,000. Collections of rainbow-trout eggs wer also made at Fish Lake during the spring of 1923, the statio receiving 882,000.

During April and May eggs from wild rainbow trout to th number of 1,500,000 were taken at the Meadow Creek field statio in Madison Valley, Mont. Some trouble was experienced in fertili ing them and the losses to the eyed stage were abnormally larg only 810,000 good eggs resulting from the work. These were of ex cellent quality, however. At the Bozeman (Mont.) station the enti pond system is being remodeled, and when the work is complete the capacity of the station for rearing fry and fingerling fish will b materially increased.

A very successful season was experienced in the propagation o blackspotted trout in the Yellowstone Park during the summer 1922 under the direction of the superintendent of the Leadvil (Colo.) station. The egg collections, as compared with the previo year, were nearly doubled and the output of fry was proportionate

the young fish resulting from egg collections in this field in building up fishing in the Yellowstone Park, and with this end in view extensive rearing and planting arrangements are under way. Operations in this field during 1923 were undertaken late in May, under the supervision of the district supervisor of the Mississippi Valley rescue station, and 4,794,000 eggs had been secured up to and including June 30.

Egg collections in the Saratoga (Wyo.) field practically were confined to brook trout and rainbow trout, though a few Loch Leven trout eggs were taken from brood stock carried in the station ponds. The operation of the recently constructed rainbow-trout field station on Sage Creek during the spring months was made exceedingly difficult by the almost impassable mountain roads, which were still heavily blocked with snow on May 1. The substation was finally reached, as a result of great effort, and a fairly successful season's work was accomplished. Low-water stages in the Pathfinder Reservoir caused an unusually light run of fish. Eggs were taken throughout the month of May and up to June 7, the total collection amounting to 1,237,150.

The season's output of trout from Manchester (Iowa) station was very seriously curtailed by the flooding of the station reservation during a heavy storm in July, 1922, at which time a large number of brood brook and rainbow trout were washed from the ponds and perished on the station grounds. This loss was partially overcome through the donation of a considerable number of adult brook trout by the Sportsmen's Club, of Calmer, Iowa, and small consignments of rainbow-trout eggs received in the following spring from the Madison Valley (Mont.) and Springville (Utah) fields. Part of the fry resulting from these western eggs will be reared for the purpose of replenishing the depleted brood stock.

During March and April a heavy mortality occurred among the young brook trout at the Hartsville (Mass.) station. It was found impossible to check it by any of the methods of treatment usually applied, and before the distribution could be made the stock had been reduced fully 40 per cent by losses. An investigation showed the presence of the parasite Octomitus, elsewhere referred to in this report, and the mortality was probably due to it, possibly aggravated by unfavorable water conditions which may have reduced the resistance of the young fish.

At the newly established Roaring River auxiliary of the Neosho (Mo.) station the results of the first season in rainbow-trout propagation were disappointing, only 958,720 eggs being obtained from the 3,000 adult and 7,000 yearling fish on hand. The low egg production is attributed to underfeeding of the brood stock by the owner of the ponds. A more satisfactory season's work was experienced at Bourbon, Mo., where another field auxiliary of the Neosho station was operated for the first time. An arrangement was entered into with the owner of the property whereby the bureau is to receive two-thirds of all the fingerling fish produced. As the site is in the eastern part of the State, its use as a fish-rearing plant will not only effect a material saving in distribution expenses but a greater number of fish than formerly will be available for stocking waters in that section of the country. During the year the bureau

leased a private pond system at Langdon, Kans, to be operated a an auxiliary of the Neosho station for the production of bass an crappie. The work was started in the spring of 1923, but owin to flooded conditions the output of fish was small.

Owing to the adverse weather conditions encountered, the produc tion of pond fishes was below normal at several of the stations en gaged in that branch of fish culture. The most serious reduction wa at the stations located at White Sulphur Springs, W. Va., North ville, Mich., Mammoth Springs, Ark., and Erwin, Tenn., at all o which points violently fluctuating air and water temperatures durin the spawning season caused the destruction of many nests of eggs More favorable natural conditions obtained at the Tupelo (Miss.) Orangeburg (S. C.), and Louisville (Ky.) stations, and the outpu of bass and allied species from those stations was the largest in thei history.

The spawning of buffalofish at the Atchafalaya (La.) statio extended from February 15 to March 28, and during this perio approximately 179,000,000 eggs were secured. As at many othe points, the work was retarded and curtailed by unseasonable weathe and water conditions. On March 5 all lowlands in the vicinity of th hatchery were inundated by flood waters coming down from th Ouachita River. The salts and oil with which the flood water were charged put a stop to the run of spawning fish and also pollute the hatchery water, killing the entire stock of eggs on hand at th time. From then on to the close of the spawning season all egg secured were fertilized and immediately returned to the waters fro which the parent fish were taken.

The work of rescuing stranded food fishes from overflowed land bordering the Mississippi River was taken up July 1 and prosecute daily until the 1st of November, when freezing weather necessitate its discontinuance. The field of operations extended from Prescot Minn., to Andalusia, Ill., and the rescued fishes included nearl every food species native to the region. Of the 139,799,031 fis handled in the course of the season, 1,164,952 were distributed t applicants, and the remainder was released in the Mississippi Rive and its tributaries. The smaller results obtained, as compare with the previous year, were due to the abnormal water stages in th river during the usual salvage period.

In view of the difficulty experienced in transporting or holdin for later distribution the crappie and sunfish rescued during ex tremely warm weather, some experiments were made at the Home station with the copper-sulphate treatment for the prevention an cure of fungoid growths. As a result of the tests, it was found tha the very small crappie and sunfish were too weak to withstand th treatment, but that it might be advantageously applied to the large fishes and to the more vigorous individuals among the smaller one Its general use therefore will be resorted to hereafter in handlin and holding fish of these species at the several collecting points in th rescue field.

ALASKA FISHERIES SERVICE.

EXTENT OF THE ALASKA FISHERIES.

The Alaskan salmon industry returned to practically normal proportions in the season of 1922 after its decline in 1921. Many salmon canneries were reopened and 15 new ones established, making a total of 123 plants operated as against 83 in the previous year. A number of plants remained closed, in some instances operations being carried on jointly by two or more companies at one plant. Market conditions also improved, thus promising a successful season. The larger production in 1922 resulted chiefly from the unusually heavy run of humpback salmon in southeastern Alaska.

The catch of salmon in the Alaska fisheries in 1922 was 72,370,400 fish, of which 33,898,772 were red or sockeye salmon, 30,589,342 humpback or pink salmon, 5,273,883 chum or keta salmon, 1,838,094 coho or silver salmon, and 770,309 king or spring salmon. Apportioned by geographical districts, the catch in southeast Alaska was 31,055,302 fish; central Alaska, 15,612,843 fish; and western Alaska, 25,702,255 fish. Comparing these figures with the returns for 1921, there was a total increase of about 91 per cent. All species, with the exception of kings, were taken in greater numbers. The number of humpbacks taken in 1922 was an increase of about 327 per cent over the take in 1921.

The 123 canneries utilized the greater part of the catch of salmon in the canned pack, which comprised 4,501,652 cases with a market value of $29,787,193, an increase of 1,904,826 cases, or approximately 72 per cent, and $10,154,449 in value over the previous year. The pack of all species, except kings, was larger.

Other salmon products were 4,266,050 pounds of mild-cured fish, valued at $821,169; 3,585,100 pounds of pickled fish, valued at $248,015; 3,849,153 pounds of frozen fish, valued at $261,094; 3,802,729 pounds of fresh fish, valued at $271,869; 906,550 pounds of dried or smoked fish, valued at $148,464; 774,000 pounds of fertilizer, valued at $23,438; and 12,989 gallons of oil, valued at $5,015; the total value of the products of the salmon industry of Alaska in 1922 being $31,566,257.

The herring fishery ranked next to the salmon fishery in 1922, totaling 35,995,450 pounds of Scotch-cured fish, valued at $2,030,975; 237,850 pounds of Norwegian-cured fish, valued at $14,009; 240,000 pounds of dry salted for food, valued at $9,600; 425,241 gallons of oil, valued at $144,418; 1,646 tons of fertilizer, valued at $98,528; and 3,488,615 pounds of bait, valued at $31,586.

The halibut fishery produced 7,886,764 pounds of fresh fish, valued at $772,610, and 3,188,473 pounds of frozen fish, valued at $262,357.

The cod fishery yielded a catch valued at $464,169 and the whale fishery $409,518. Clam products were valued at $185,007 and shrimp products at $126,690. Other minor items were: Crabs, $47,379; trout, $5,914; sablefish, $1,538; flatfish, $367; and ling cod, $26.

The entire Alaska fishery industry gave employment to 21,974 persons, represented an investment of $54,590,302, and yielded products valued at $36,170,948.

A detailed account of the extent and condition of the Alaska fisheries in 1922 and of the activities of the bureau under the laws and regulations for the protection of the fisheries is embodied in the annual report of the Alaska service for that year.[1]

ENFORCEMENT OF FISHERY LAWS AND REGULATIONS.

Primarily for the purpose of enforcing the fishery laws and regulations, the bureau in 1922 operated 8 of its own vessels in Alaskan waters, and in addition 22 small boats were chartered for varying periods and 6 launches, maintained on Bristol Bay chiefly for the destruction of predatory fish, were used for patrol service during the fishing season. On account of shortage of funds the force of temporary stream guards, of which there were 60 in 1922, will necessarily be employed for a shorter period in the season of 1923. The total force aggregates 19 statutory employees, 25 men on vessels, and 69 stream guards and temporary assistants.

A number of prosecutions were made for violations of the fishery laws and regulations in 1922, the majority being for fishing in streams or within the prohibited distances of the mouths of streams. In the cases disposed of fines and costs amounted to about $2,500, with two jail sentences of 30 days and one of 20 days. A few cases had not been brought to trial at the end of the year. The stationing of stream guards at the mouths of many salmon streams operated, without doubt, as a deterrent to unlawful fishing in protected waters and thus aided materially in conserving the runs of salmon.

Markers were erected at the mouths of a number of streams that heretofore had been unmarked, and those destroyed or defaced were replaced. Some work was also done to clear streams of obstructions and render them more easily accessible to spawning salmon. Investigations were made and results reported to the Federal Power Commission in regard to the effect proposed power projects on certain streams would have on the runs of salmon.

PRIVATE SALMON HATCHERIES.

In 1923 two private salmon hatcheries were operated in Alaska as authorized by law. The hatchery of the Alaska Packers Association on Naha Stream liberated 16,985,000 red salmon fry in the fiscal year 1923, and that of the Northwestern Fisheries Co., located on Hugh Smith Lake, liberated 6,007,000 red salmon fry in the same period. The total rebate of taxes on canned salmon, at the rate of 40 cents per 1,000 fry released by these hatcheries, amounted to $9,196.80.

Representatives of the Washington State Fish Commission made collections of humpback-salmon eggs in Prince William Sound in the season of 1922. Very heavy losses occurred during the early stages of the work, and on request of the bureau the collecting of eggs was discontinued. The eggs on hand were eyed, and shipments made in October totaled 14,571,708 eyed humpback-salmon eggs.

[1] Alaska Fishery and Fur-Seal Industries, in 1922. By Ward T. Bower. (Bureau of Fisheries Document No. 951.)

NEW SALMON-FISHERY REGULATIONS.

Under date of November 3, 1922, an Executive order was issued creating a reserve designated as the Southwestern Alaska Fisheries Reservation, including Bristol Bay, Kodiak and Afognak waters, and Cook Inlet. Hearings were held at Seattle and San Francisco the latter part of November to consider necessary restrictions on fishing in the reserved districts. Revised regulations for the Alaska Peninsula Fisheries Reservation and regulations for the administration of the newly created Southwestern Alaska Fisheries Reservation were issued December 14 and 16, 1922, respectively. The full text of these regulations and of the Executive order of November 3 will be found in the report of Alaska Fishery and Fur-Seal Industries in 1922.

For the season of 1923 a total of 90 formal permits for fishery operations within these reserves were issued by the Secretary of Commerce, of which 9 were canceled before the beginning of the fishing season, leaving 81 under which operations were carried on. Eight supplementary permits were granted in connection with permits previously issued. Permits effective in the season of 1923 are as follows:

Alaska Peninsula Fisheries Reservation.

No. 1.	Alaska Packers Association	Chignik.
No. 2.	Columbia River Packers' Association	Do.
No. 3.	Northwestern Fisheries Co	Do.
No. 4.	Shumagin Packing Co	Squaw Harbor.
No. 5.	P. E. Harris & Co	False Pass.
No. 6.	Pacific American Fisheries	Ikatan.
No. 7.	Pacific American Fisheries	King Cove.
No. 8.	Everett Packing Co	Herendeen Bay.
No. 9.	Fidalgo Island Packing Co	Do.
No. 10.	Pacific American Fisheries	Nelson Lagoon.
No. 11.	Pacific American Fisheries	Port Moller.
No. 12.	Phoenix Packing Co	Herendeen Bay.
No. 13.	George Albert	Port Heiden.
No. 70.	Union Fish Co	10 stations.
No. 86.	Brown Fish Co	2 stations.

Southwestern Alaska Fisheries Reservation.

BRISTOL BAY DISTRICT.

No. 14.	Alaska Packers Association	Kvichak.
No. 15.	Alaska Packers Association	Do.
No. 16.	Alaska Packers Association	Naknek.
No. 17.	Alaska Packers Association	Do.
No. 18.	Alaska Packers Association	Do.
No. 19.	Alaska Packers Association	Egegik.
No. 20.	Alaska Packers Association	Ugashik.
No. 21.	Alaska Packers Association	Nushagak.
No. 22.	Alaska Packers Association	Do.
No. 24.	Alaska-Portland Packers' Association	Naknek.
No. 25.	Alaska Salmon Co	Kvichak.
No. 26.	Alaska Salmon Co	Wood River.
No. 27.	Bristol Bay Packing Co	Koggiung.
No. 28.	Carlisle Packing Co	Koggiung River.
No. 29.	Columbia River Packers' Association	Nushagak.
No. 30.	International Packing Co	Ugashik.
No. 31.	Libby, McNeill & Libby	Egegik.
No. 32.	Libby, McNeill & Libby	Ekuk.
No. 33.	Libby, McNeill & Libby	Nushagak.

No. 34. Libby, McNeill & Libby	Lockanok.
No. 35. Libby, McNeill & Libby	Libbyville.
No. 36. Libby, McNeill & Libby	Koggiung.
No. 37. Libby, McNeill & Libby	Igushik.
No. 38. Naknek Packing Co	Naknek.
No. 39. Peter M. Nelson	Kvichak.
No. 40. Northwestern Fisheries Co	Naknek.
No. 41. Northwestern Fisheries Co	Nushagak.
No. 42. Red Salmon Canning Co	Ugashik.
No. 43. Red Salmon Canning Co	Naknek.
No. 72. Peter M. Nelson	Copenhagen Creek.
No. 74. Peter M. Nelson	Igushik.
No. 77. Bering Sea Salmon Packing Co	King Salmon Creek.
No. 85. Alaska-Portland Packers' Association	Nushagak.
No. 88. Alaska Calmon Co	Kvichak.

COOK INLET DISTRICT.

No. 44. Alaska Packers Association	Kasilof.
No. 46. Anchorage Packing Co	Anchorage.
No. 48. Fidalgo Island Packing Co	Port Graham.
No. 50. Kamishak Canning Co	Kamishak Bay.
No. 51. Libby, McNeill & Libby	Kenai.
No. 52. North Coast Packing Co	Ninilchik.
No. 53. Northwestern Fisheries Co	Kenai.
No. 66. Delorne and Wilson	Chisik Island.
No. 75. H. J. Emard	Moose Point.
No. 81. Pioneer Canneries (Inc.)	Snug Harbor.
No. 82. Arctic Packing Co	English Bay.
No. 84. Charles B. Myers	Paulie Creek.
No. 90. Alaska Year-Round Canneries Co	Seldovia.

KODIAK-AFOGNAK DISTRICT.

No. 56. Alaska Packers Association	Larsen Bay.
No. 57. Northwestern Fisheries Co	Uyak.
No. 58. Robinson Packing Corporation	Zachar Bay.
No. 61. Michael P. Galvin	Our Island.
No. 62. Kodiak Fisheries Co	Kodiak.
No. 63. Katmai Packing Co	Uzinki.
No. 64. Kodiak Island Fishing & Packing Co	Uganik Bay.
No. 65. Pajoman & Trout	Raspberry Island.
No. 67. W. J. Erskine Co	Kodiak.
No. 68. Alaska Sea Food Products Co	Three Saints Bay.
No. 69. San Juan Fishing & Packing Co	Uganik Bay.
No. 71. The W. J. Imlach Packing Co	Uzinki.
No. 76. Uganik Packing Co	Uganik Bay.
No. 78. Opheim & Sargent	Shuyak Island.
No. 79. Hemrich Packing Co	Kukak Bay.
No. 80. R. M. Dahl	Uyak Bay.
No. 83. Breyer & Freund	Raspberry Island.
No. 87. Alitak Packing Co	Lazy Bay.
No. 89. Hopp & Danielsen	Uganik Bay.

Permits for operations on a small scale have also been granted to a number of local residents by the bureau's representatives in the districts, 27 such permits having been issued in the Alaska Peninsula Fisheries Reservation, 90 in Bristol Bay district, 120 in Cook Inlet, and 60 in the Kodiak-Afognak district.

SPECIAL STUDIES AND INVESTIGATIONS.

Mention of these is made in a preceding section of this report, but it appears desirable to refer to them here to complete in one section a record of the bureau's activities in Alaska.

Counts of red salmon ascending to their spawning grounds were made on Karluk and Chignik Rivers in the season of 1922 and are being renewed in the season of 1923. Inasmuch as these streams afford an excellent opportunity for determining the commercial catch of salmon and at the same time enable satisfactory results in counting salmon passing upstream, it is felt that reliable information as to the percentage of escapement necessary to perpetuate the runs without diminution can be developed eventually. This will necessitate counts over a series of years. Similar counting operations were inaugurated in the season of 1923 on Nelson River, flowing into Herendeen Bay, but were abandoned on account of physical difficulties, and on two streams tributary to Alitak Bay on Kodiak Island.

Under the direction of Dr. C. H. Gilbert, important investigations were made in western Alaska in 1922 and will be continued upon a larger scale through the season of 1923, with a view to determining migration routes of salmon. Interesting information has already resulted in this connection from the tagging of 4,000 red salmon at Ikatan Bay and other waters of that general region in 1922. While most of the fish subsequently recaptured were taken in the vicinity where tagged, a number were secured in Bristol Bay and a few on Cook Inlet, and one even on the Kuskokwim River.

A party remained over the winter in the Nushagak region to investigate the salmon-spawning grounds and endeavor to ascertain the size of the escapement in 1922. A specialist was sent to the Cook Inlet district in the season of 1923 to investigate the extent of the clam beds and thus secure data as a basis for the proper regulation of the fishery. A study of the salmon fishery of the Kuskokwim River was made in 1922, and the destruction of predatory fishes in streams tributary to Bristol Bay was again conducted along lines followed in recent years.

PROTECTION OF WALRUS AND SEA LIONS.

No changes were made in the walrus and sea lion regulations issued April 21, 1921, nor were any violations reported during the year.

NEW LEGISLATION NEEDED.

The fisheries of Alaska are being administered under the provisions of the act of June 26, 1906. This law is wholly inadequate and there is urgent need of new legislation to meet present-day conditions. The expansion of the fishery and modifications in methods make effective conservation impossible in many sections. This situation has been brought to attention repeatedly but so far without avail, and it is earnestly hoped that at its next session Congress will afford the desired relief. While the situation has been helped through the creation of reservations by Executive order, that expedient is regarded merely as a temporary measure pending the enactment of the legislation necessary for adequate control of a grave situation. To those who have opposed fishery reservations upon grounds of principle, the answer is that the fishery must be saved now and the reservation policy is the only possible means until Congress acts. The

best means available have been used to alleviate a critical situation until the final cure, through added legislation, can be effected.

ALASKA LEGISLATURE.

At its regular session early in the year 1923, the Territorial Legislature of Alaska passed several laws bearing upon the fisheries. One of these added materially to the license-tax rates on products and on certain fishing apparatus, another provided for the licensing of fishermen, and the third imposed certain closed seasons on fishing in the waters of southeast Alaska.

ALASKA FUR-SEAL SERVICE.

GENERAL ACTIVITIES AT THE PRIBILOF ISLANDS.

The administrative work on the Pribilof Islands was carried on in the usual manner by the bureau's staff of 15 white employees. The population of the two islands consists of about 325 native men, women, and children, who carry on the physical work of sealing and foxing and other activities, supervised by the bureau's representatives. Compensation for these services is in the form of nominal cash payments for the work of taking seal and fox skins, together with subsistence, including food, fuel and clothing, and living quarters, school facilities, and medical attention. In addition to the island natives, from 50 to 60 native laborers are secured each year from the Aleutian Islands for the period of active sealing.

The work of the bureau on the islands covers a wide range, for, in addition to sealing and foxing operations, it involves the erection of buildings, construction of roads, maintenance of machinery and equipment necessarily various in so remote and isolated a region, construction and repair of small boats used for landing cargo, installation of water-supply and electric-lighting systems for the villages on each island, operation of a by-products plant for the production of oil for use in dressing sealskins, preparation of seal meat for feeding foxes during the winter season, and the keeping of extensive records of all activities.

Supplies for the Pribilof Islands were transported from Seattle by chartered commercial vessels during the summer of 1922, but in 1923 it was again possible to secure cargo space on the naval radio tender *Gold Star*, which also transported a number of passengers for the bureau. Passengers and small lots of supplies were also carried by vessels of the Coast Guard and by the commercial steamer *Buford* in the spring of 1923.

The process of removing pelts by stripping from the body of fur seals, developed within the last two or three seasons, was continued along more extensive lines. This process requires certain marginal cuts to permit the literal pulling off of the pelt, but does away with the use of knives, as formerly, for separating the skin from the underlying tissues. This reduces or practically eliminates cuts, to the consequent enhancement of the value of the pelts. The improved process of stripping necessitates washing and blubbering

the pelts on the islands before they are salted. In the season of 1922 approximately 50 per cent of the skins were taken in this manner. Expansion in facilities will make possible its application to about 75 per cent in 1923. It is planned to remove practically all skins in this way during the next season.

A party headed by Assistant Secretary Huston was at the Pribilof Islands from July 11 to 19, 1922, for the purpose of observing methods and giving consideration to administrative policies. Included in the party were Dr. Leonhard Steineger, of the U. S. National Museum, a noted authority in regard to the fur seals of the north Pacific, and Ward T. Bower, of the Bureau of Fisheries. After leaving the Pribilofs, visits were made to the Commander Islands to note conditions regarding the Russian fur-seal herd, and to Robben Island, to which the Japanese herd resorts. Consideration was also given to fishery and fur-seal matters in Japan and elsewhere.

A representative of the bureau authenticated 625 fur-seal skins taken by Indians in the vicinity of Sitka, Alaska, during the spring migration of 1923, and 1 additional skin that had been taken in the spring of 1922 but not authenticated at that time. Indians also took 871 fur-seal skins off the coast of Washington, which were authenticated by the superintendent of the Neah Bay Reservation under authorization by the Department of Commerce. A patrol for the protection of the seal herd during its migration to the Pribilof Islands was conducted by vessels of the U. S. Coast Guard. Four vessels of the bureau also maintained a patrol of the sealing grounds in the vicinity of Sitka.

The bureau's vessel *Eider* performed excellent service for the islands during the first six months of the current fiscal year in which she made seven trips from Unalaska to the Pribilof Islands. One trip was made to King Cove in an effort to secure native workmen for sealing on the Pribilofs and one trip to Belkofsky to return native laborers to their homes. Early in January the vessel was ordered to Cordova for repairs and later was sent to Seattle for the installation of a Diesel engine. The vessel was still at Seattle at the end of the fiscal year but was expected to return to Alaska about the middle of July.

SEAL HERD.

The 1922 estimate of the seal herd, as of August 10, gives the total number of animals as 604,962, an increase of 23,519 over 1921. In 1922 some experiments were made in photographing sections of the rookeries, with a view to determining the practicability of the use of photography in the counting of seals. No conclusive results were obtained.

TAKE OF SEALSKINS.

The number of seals killed under Government supervision on the Pribilof Islands in 1922 was 31,156, of which 30,260 were taken during the regular season ended August 5 and the remainder in the fall and winter.

An important innovation this season has been the branding on the back with a hot iron of 5,000 3-year-old male seals for breeding purposes. This work was done before the beginning of extensive commercial killing. In addition to the 5,000 thus branded, 5,000 were temporarily marked by shearing the hair on top of the head, so that these animals were exempted from killing in the current season, and thus from abundance of caution the actual reserve of 5,000 required by law has been doubled. Since only 3-year-old seals are killed for their skins, none of these animals will be killed intentionally in later years and will thus be allowed to develop to maturity, subject only to natural mortality.

SALES OF SEALSKINS.

In the fiscal year 1923 two public auction sales of fur-seal skins were held at St. Louis. At the sale on October 9, 1922, 17,194 dressed, dyed, and machined skins brought $535,967.50, and in addition 164 raw, washed, and dried skins and 37 raw salted skins were sold for $87.55; at the sale on May 28, 1923, 18,118 dressed, dyed, and machined skins brought $564,224.75, a total of 35,513 skins and $1,100,279.80. These prices averaged approximately the same as in the previous year.

At the May sale there were also sold 55 sealskins from the Japanese herd on Robben Island, representing the share of the United States in the skins taken in 1921. They brought a total of $1,940.

As a result of the sales of fur-seal skins from the Pribilof Islands in the fiscal year 1923 the sum of $69,105.86 has been paid to Great Britain and a like amount to Japan covering value of their respective shares of skins under the terms of the North Pacific Sealing Convention of 1911.

FOXES AND REINDEER.

Herds of blue foxes of considerable commercial importance are maintained on the Pribilof Islands. To a large extent these herds support themselves, feeding on the carcasses remaining from seal killings and on the immense flocks of sea birds that nest on the islands, but winter feeding is also provided for by the preserving of seal carcasses. During the winter of 1922–23 a total of 888 blue and 29 white fox skins was taken. The prevalence of warm, wet weather on St. George Island, which has the larger herd, seriously interfered with foxing operations during the season, as the animals were able to secure food in plenty and were not forced to come to the traps for food. A breeding reserve was also marked and released on St. George Island.

The 712 blue and 21 white fox skins taken in the winter of 1921–22 were sold at public auction at St. Louis, October 9, 1922. The total amount bid was $67,310, an average of $93.18 for blue and $46 for white skins. In addition, 12 live blue foxes were sold for stocking fox farms in Alaska, delivery being made at Unalaska in September. The price received for the live animals was $175 each.

The herds of reindeer, which were introduced on the Pribilof Islands in 1911, now furnish a valuable supply of fresh meat. It

was estimated that there were approximately 400 animals on the islands at the end of the calendar year 1922, while 60 animals had been used for food during the preceding 12 months—38 on St. Paul Island and 22 on St. George.

COOPERATION WITH OTHER GOVERNMENT AGENCIES.

The International Committee on Marine Fishery Investigations met in Washington on November 10, 1922, and in Toronto on May 4, 1923. The first meeting was attended by three representatives each of the United States and Canada, and the second by two representatives of the United States and three of Canada. At the Toronto meeting the committee had the satisfaction of welcoming a representative of France, that country, by reason of its fisheries in the western Atlantic, having officially expressed a desire to participate in these conferences. The representative of Newfoundland was unable to attend either meeting. Plans were laid for coordinating certain of the marine-fisheries investigations of the countries represented.

Helpful relations have been maintained with the Bureau of Standards, Coast and Geodetic Survey, Bureau of the Census, and Bureau of Foreign and Domestic Commerce.

The National Park Service and the Forest Service have cooperated in stocking streams with fish and in facilitating fish-cultural work in other respects, and assistance to various branches of the bureau's activities has been rendered by the Bureau of Indian Affairs, the Reclamation Service, and the Geological Survey.

An assistant was again detailed to the Public Health Service for investigations of mosquito control through the agency of fishes.

The Navy Department furnished transportation for supplies and personnel to the Pribilof Islands, and the Coast Guard Service as usual extended valuable assistance on many occasions.

The Consular Service has supplied important information concerning the fisheries of foreign countries.

VESSEL SERVICE NOTES, 1923.

The steamer *Fish Hawk* has continued the hydrographic and biological survey of Long Island Sound, which was inaugurated at the end of the last fiscal year. Eight round trips, aggregating 2,213 miles of steaming, have been made, from 30 to 56 stations being covered on each trip. The *Fish Hawk* has not been extensively overhauled since 1916 and is in urgent need of repairs and new propellers, for which a special appropriation has been asked.

The steamer *Halcyon* has been engaged in carrying on a fishery investigation in the north Atlantic and in fish-cultural operations in connection with the Gloucester and Woods Hole stations. In July current observations were made on lines 150 miles each from Sandy Hook and Chatham and 25 miles from Cape Elizabeth, and April, May, and June were spent in tagging codfish in the vicinity of Nantucket. During August and September the crew was occupied in overhauling the gas boat *Kittiwake* preparatory to her transfer to Seattle, and in February valuable service was performed by the

Halcyon in keeping channels open through the ice in the harbors of Gloucester, Salem, and Manchester. In all the vessel steamed 3,575 miles.

The *Phalarope* and *Gannet* were utilized for fish-cultural and collecting work at the Woods Hole and Gloucester (Mass.) stations, respectively, and the former was brought to the Potomac River for use at the hatchery at Bryans Point, Md., during the shad season. In October her crew took the *Kittiwake* from Woods Hole to Norfolk, whence she was carried on a Navy transport to Seattle.

In addition to the steamer *Shearwater*, the bureau now operates two large gas boats, the *Curlew* and *Fulmar*, on the Great Lakes. These are attached to the fish-cultural stations at Put in Bay, Ohio, Cape Vincent, N. Y., and Charlevoix, Mich.

The supply vessel *Eider* made seven round trips between Unalaska, Alaska, and the Pribilof Islands, carrying Government employees, freight, and supplies, and two trips to Belkofsky with native laborers who had been employed on the islands. During the winter exceedingly stormy weather prevailed, which delayed operations and at times prevented the vessel from going to sea. In December an attempt was made to save the gas vessel *Lister*, which was ashore at Cape Makushin, about 40 miles from Unalaska. The wife and family of the captain were transported to Unalaska. In February the *Eider* was taken to Cordova for repairs to her engines and upper works, but as it was finally decided to equip her with new engines she proceeded to Seattle, where she arrived March 24. The old 110-horsepower engine has been removed and a 140-horsepower Diesel engine installed. It is believed the change will effect a great saving in the cost of fuel and also give the vessel needed additional power. Other changes and improvements will add to her efficiency and seaworthiness. During the year she cruised 7,420 miles.

The usual patrol and fisheries investigations were carried on in southeast Alaskan waters by the gas boats *Auklet*, *Murre*, *Petrel*, and *Widgeon;* the *Scoter* operated in Bristol Bay, the *Tern* on the Yukon River, and the *Merganser* was sent to Chignik. While these Alaska boats are on active duty only during spring, summer, and early fall months, the service they are called on to perform is onerous, exacting, and often dangerous. They cruised during the year from 4,000 to 7,300 miles each. During inactive periods their crews are kept busy with repairs and upkeep, and in addition are called on for other work not directly pertaining to vessels and boats.

The *Kittiwake*, originally obtained from the Navy, reached Seattle in the spring of 1923, and is being refitted and furnished with a more powerful engine to fit her for the needs of the Alaska service. In May the small gas boat *Ibis* was purchased for use at Chignik.

The activities of vessels in Alaska are briefly stated in the section of this report dealing with the bureau's work in the Territory.

APPROPRIATIONS.

The regular appropriations for the bureau for the fiscal year 1923 aggregated $1,262,090, as follows:

Salaries	$456,960
Pay, officers and crews of vessels for Alaska service	31,630
Miscellaneous expenses:	
Administration	11,000
Propagation of food fishes	375,000
Maintenance of vessels	100,000
Inquiry respecting food fishes	40,000
Statistical inquiry	20,000
Protecting sponge fisheries	3,000
Protecting seal and salmon fisheries	165,000
Repairs to fish-cultural stations:	
Yes Bay, Alaska	7,000
Duluth, Minn	6,000
Gloucester, Mass	6,500
Establishment of station on Mississippi River	40,000
Total	1,262,090

Respectfully submitted.

HENRY O'MALLEY,
Commissioner of Fisheries.

To Hon. HERBERT HOOVER,
Secretary of Commerce.

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